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REPORT

USAF TACTICS AGAINST AIR & GROUND DEFENSES IN SEA (U) NOVEMBER 1968 - MAY 1970

25 SEPTEMBER 1970

HQ PACAF

Directorate, Tactical Evaluation
CHECO Division

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PROJECT CHECO REPORTS

The counterinsurgency and unconventional warfare environment of Southeast Asia has resulted in the employment of USAF airpower to meet a multitude of requirements. The varied applications of airpower have involved the full spectrum of USAF aerospace vehicles, support equipment, and manpower. As a result, there has been an accumulation of operational data and experiences that, as a priority, must be collected, documented, and analyzed as to current and future impact upon USAF policies, concepts, and doctrine.

Fortunately, the value of collecting and documenting our SEA experiences was recognized at an early date. In 1962, Hq USAF directed CINCPACAF to establish an activity that would be primarily responsive to Air Staff requirements and direction, and would provide timely and analytical studies of USAF combat operations in SEA.

Project CHECO, an acronym for Contemporary Historical Examination of Current Operations, was established to meet this Air Staff requirement. Managed by Hq PACAF, with elements at Hq 7AF and 7AF/13AF, Project CHECO provides a scholarly, "on-going" historical examination, documentation, and reporting on USAF policies, concepts, and doctrine in PACOM. This CHECO report is part of the overall documentation and examination which is being accomplished. Along with the other CHECO publications, this is an authentic source for an assessment of the effectiveness of USAF airpower in PACOM.


ROLAND A. CAMPBELL, Major General, USAF
Chief of Staff

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Maurice L. Griffith

MAURICE L. GRIFFITH, Colonel, USAF
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FOREWORD

Tactics against air and ground defenses pose a dilemma. Any effort to avoid or suppress defenses invariably detracts from effectiveness of the primary mission. In dive bombing, the higher a pilot must pull out to avoid ground fire, the lower his accuracy. Sorties fraggged for combat air patrol or gun suppression are unavailable for striking interdiction targets. Carrying electronic countermeasures (ECM) gear to permit an aircraft to survive in an area defended by surface-to-air missiles or radar-controlled antiaircraft artillery eliminates two pylons of ordnance.

Guilio Douhet, fifty years ago, argued that offensive potential of aircraft was so great and their defensive potential so small, designers, commanders, and aircrews should give their entire attention to the offensive, accepting whatever losses the defense might inflict. This unrealistic reasoning proved costly to the United States Army Air Corps in World War II.

Nearly all commanders and aircrews today accept a more realistic view, knowing that defenses reaching a certain level must be countered. Effective tactics must be carefully tailored to take advantage of the strengths of the particular weapon system and to protect against the particular threat anticipated. The USAF weapons systems employed in Southeast Asia were numerous and varied: the threat was ever

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changing. Defensive tactics impinged upon nearly every aspect of aerial operations from the choice of routing, accepting the risk of mid-air collision while operating without lights, to making an airfield traffic pattern in guerrilla-infested areas.

This continuing CHECO Report, "USAF Tactics Against Air and Ground Defenses in SEA, November 1968 - May 1970," is organized geographically to present a general survey of tactics employed by a variety of USAF aircraft engaged in variegated missions in a dynamic, hostile environment, ranging from small arms fire to sophisticated electronics and missilery. Other CHECO Reports in this series are: "Air Tactics Against NVN Air/Ground Defenses," 27 February 1967, and "USAF Air Tactics Against NVN Air/Ground Defenses, Dec 66 - 1 Nov 68," 17 October 1969.

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CHAPTER I
THE THREAT

The air and ground defenses against which USAF aircraft operated in Southeast Asia ranged from the relatively simple environment of small arms and automatic weapons in the Republic of Vietnam (RVN) to one of the most highly defended areas the USAF had ever flown against-- North Vietnam. In this country, conventional antiaircraft artillery (AAA)--up to 100-mm in caliber--MIG interceptors, and surface-to-air missiles (SAMs), were integrated by a ground radar net.

In Laos, the situation revolved between these two extremes, but during this reporting period, it became similar to the defenses found in North Vietnam. Large numbers of 57-mm antiaircraft guns, along with 85-mm and 100-mm weapons in smaller quantities, were deployed in defense of lines of communications frequently referred to as the Ho Chi Minh Trail. USAF aircraft operating near the North Vietnamese Border were also threatened by more sophisticated weapons in the air defense arsenal of North Vietnam.

The threat faced by aircrews in the Republic of Vietnam was a continuing one: for the 88 weeks of this reporting period, the USAF lost an average of slightly more than one fixed-wing aircraft per week (Fig. 1). Viet Cong and North Vietnamese riflemen usually fired barrages. Gunners aimed automatic rifles and machine guns, estimating

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distance and lead by such rules of thumb as the ability to discern the pilot's head in the cockpit (200 meters, lead 4 times the length of propeller aircraft, 8 times the length of a jet).^{1/} Small arms fire frequently went unnoticed by aircrews, and therefore unreported, but it accounted for a significant portion of battle damage, though relatively few losses. Even in supposedly secure areas, aircraft took small arms hits in the traffic pattern. As late as May 1970, for example, practice instrument approaches were prohibited at Long Than North, 25 miles east of Saigon; and on GCA at Bien Hoa, even closer to the capital, pilots preferred to fly above the glide path whenever weather conditions permitted.^{2/}

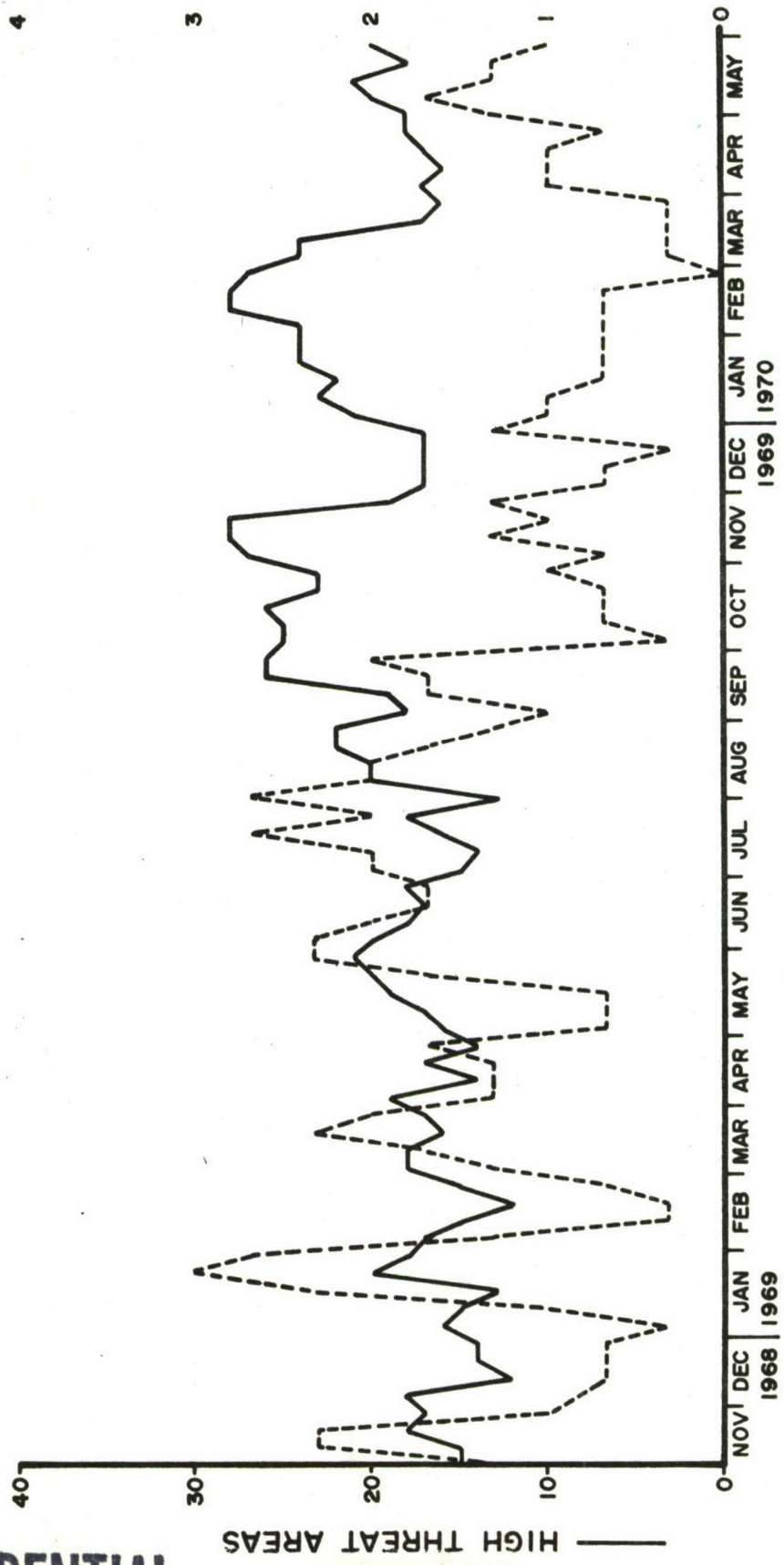
The most important antiaircraft weapons in South Vietnam were machine guns of 12.7 and 14.5-mm, in single, twin, and quad barrel configurations. The guns were handy and could be brought into action in a few seconds. With rates of fire of 600 rounds per minute per barrel for short cycles and effective ranges of 3,300 and 4,600 feet, respectively, these weapons accounted for most of the combat losses. Both forward air controllers and strike aircraft were vulnerable to these weapons, the latter particularly during recovery from ordnance delivery dives. The gun crews were tireless and proficient in protecting their positions by frequent movement, digging, and camouflage, so that positions were rarely seen unless the weapons fired. Guns of 23- and 37-mm were captured in the A Shau Valley during the summer of 1968. Since that time, aircrews continued to report firings from such weapons near the Laotian and

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HIGH-THREAT AREAS AND USAF FIXED-WING
COMBAT LOSSES IN SOUTH VIETNAM. LOSSES
ARE 3-WEEK MOVING AVERAGES.

SOURCE: 7AF WAIS

FIGURE 1

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Cambodian Borders. These guns had sustained rates of fire of 200 rounds and 80 rounds per minute, respectively, and effective slant ranges of 6,600 and 8,200 feet.^{3/}

Seventh Air Force kept track of the anti-aircraft threat in South Vietnam by designating high-threat areas based on reconnaissance, aircrew reports of at least two AAA firings or intense and continuous small arms/automatic weapons fire, downed aircraft, and other intelligence sources. Such designations were withdrawn after varying lengths of time, based on judgment of an analyst. The number of high-threat areas in South Vietnam ranged from 12 to 28, with no particular pattern apparent (Fig. 1).^{4/}

The threat to aircraft in South Vietnam during the period was virtually constant. In Laos, on the other hand, the threat grew steadily. All smaller weapons were located there, plus larger caliber guns, of which the 37-mm was the most widely deployed. Few interdiction missions could be flown high enough to avoid its effective range. The guns were frequently shifted between prepared sites, which usually took the form of four individual firing positions roughly fashioned in a square. The positions were connected by trenches, and each gun was protected by packed earth revetments. Foxholes were available for the crew close to each gun position, and ammunition was stored close by in trenches. The 57-mm gun was much less common. Its maximum effective slant range was 13,100 feet with optical sighting, 19,700 feet with gun-laying radar.

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No gun control radar was known to be employed in Laos; however, stray electronic intelligence reports continued to raise the possibility. The 57-mm gun had a rate of fire of 70 rounds per minute.^{5/}

A few of the largest antiaircraft guns in Southeast Asia, the 85- and 100-mm, were deployed in Laos during the period. The Chinese used these guns to protect roads they were building in northwestern Laos; but of more significance to U.S. aircrews, the North Vietnamese positioned 85- and 100-mm guns along their side of the Laotian Border, close enough that cross-border firings could and did threaten USAF aircraft over Laos. Occasionally, such guns were moved across the border. The 85-mm gun had a maximum effective slant range of 27,500 feet, the 100-mm, 39,000 feet. Both had rates of fire of 15 rounds per minute. They had been controlled by radar in North Vietnam but, as noted previously, there was no positive evidence of radar control in Laos.^{6/}

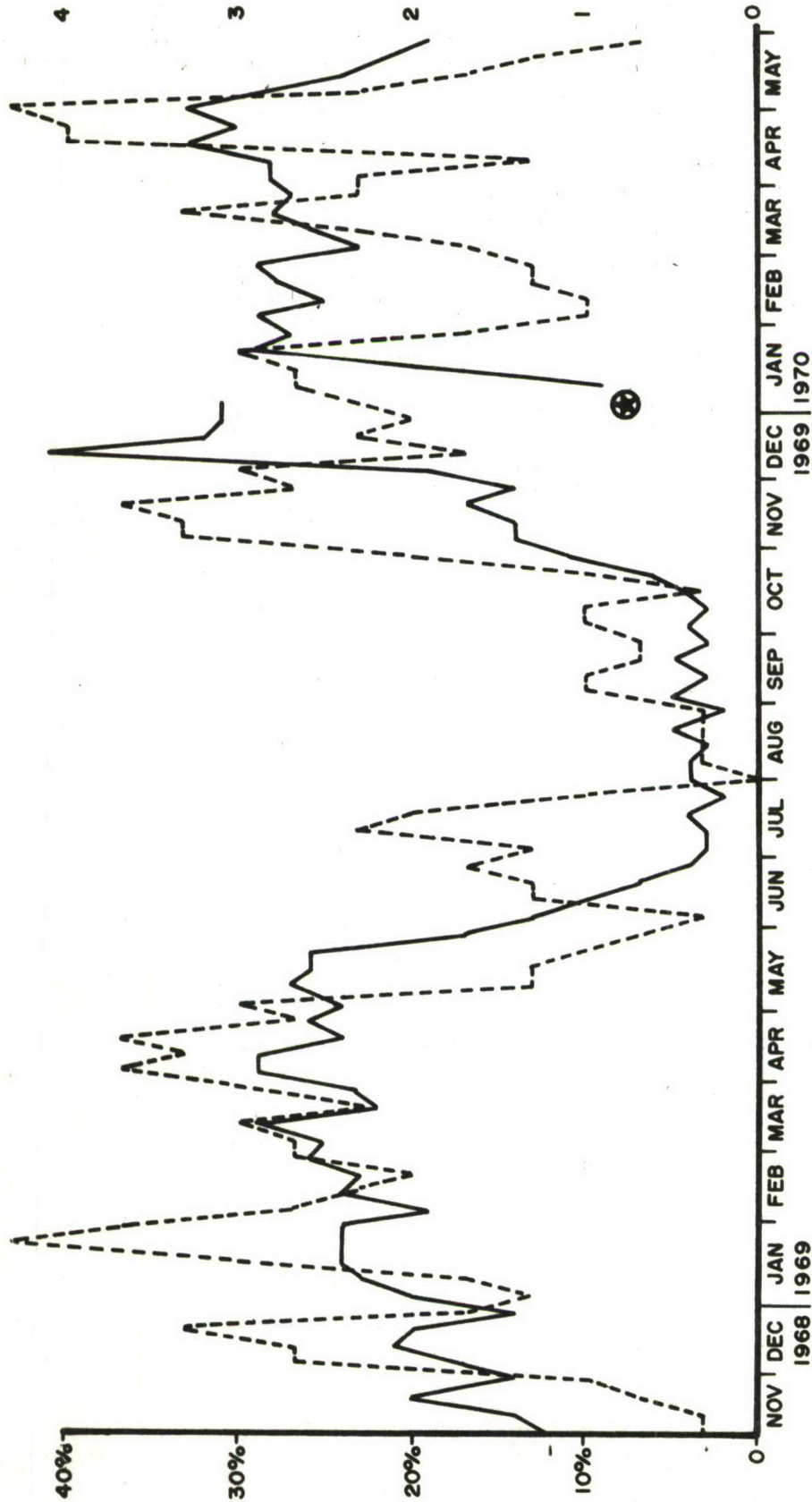
At the time of the bombing halt on 1 November 1968, there were about 200 guns of all calibers in Laos. When the USAF shifted its emphasis from North Vietnam to Laos, the North Vietnamese presumably redeployed large numbers of guns to that area. At any rate, the gun count in Laos rose rapidly, reaching about 500 by the first of 1969 and peaking at almost 600 at the end of the dry season, May 1969. Then the active gun count dropped, as many weapons were stored in caves, to be returned to service when the rains stopped in October and November. Thereafter the count continued to rise, surpassing 650 at the beginning of 1970, 850 in

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DEFENSIVE REACTION

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DEFENSIVE REACTION RATE (SORTIES FIRED ON/
TOTAL SORTIES, ALL SERVICES) AND USAF
FIXED-WING COMBAT LOSSES IN LAOS. LOSSES
ARE 3-WEEK MOVING AVERAGES.

SOURCE: 7AF WAIS

⊗ DATA BASE WAS CHANGED
1 JAN 70 TO INCLUDE SORTIES
PREVIOUSLY OMITTED.

FIGURE 2

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February, reaching 983 in early May 1970. By that time, the passes and roads of the Ho Chi Minh Trail complex were depicted on Seventh Air Force intelligence maps as continuous bands of high-threat areas. For the 19 months, USAF combat losses of fixed-wing aircraft in Laos totaled 160, all either known or presumed to be due to ground fire. Figure 2 shows the weekly losses and the AAA reaction rates.^{7/}

While the gross gun count and the numbers of larger caliber guns increased, mobile defense for truck convoys was added by the introduction of Soviet armored vehicles carrying two automatic weapons, and by mounting antiaircraft machine guns on ordinary truck beds. There were always four to five times as many prepared positions as there were guns, with the weapons being shifted rapidly from one site to another. During this reporting period, gun sites were largely lightly revetted; however, later in Laos, more heavily constructed revetments assumed the character of prepared positions, so that the defense structure along principal roads took on more permanence. Sites were camouflaged adroitly, using vines and trees trained to trellises and netting made from or covered with local vegetation. Frequently sites were so well hidden that, even when found, photo intelligence could not determine the exact caliber and number of guns until after strike ordnance had blown away the cover.^{8/}

As the gun crews gained experience, they displayed more subtle tactics. Not all the guns in an area would fire against every pass made by an aircraft, so that pinpointing the sites for subsequent attack was

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further complicated. Decoys were built, sometimes made into flak traps by the addition of real guns near enough to fire on strikes that took the bait. While the 23-mm and heavier guns were located on the routes and near the point targets to be protected, machine guns were located randomly, particularly on ridgelines some distance from the roads. The gunners frequently allowed one or two passes to be made without opposition, hoping to lull the aircrews into complacency while studying the aircraft patterns and altitudes, then opening up in barrage fire. The gun crews knew how to use the bases of clouds to estimate heights and how to evaluate terrain to determine the most likely approach routes.^{9/}

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1973*

Two more unusual weapons of marginal utility were employed by the ground defense forces in southern Laos. Starting in 1969, unguided rockets were fired at USAF gunships. The frequency of firings increased dramatically in early 1970, and the rockets were more often associated with AAA fire. The rockets, probably 122- and 140-mm, did not have proximity fuses and miss distances were often in miles. No U.S. aircraft was lost to them.^{10/} In early 1970, aircrews began seeing unusual ground lights, some of which appeared on infrared observation devices, while others were visible to the unaided eye. The North Vietnamese may have been experimenting with some type of aid to night AAA, or the lights may have been intended only to harass aircrews.^{11/}

The heavier AAA was only one aspect of the air defense threat that spilled over the North Vietnamese Border into Laos. The North Vietnamese

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also moved SAM sites close to the border and on two occasions fired on U.S. aircraft over Laos. The threat, implicit in the growing North Vietnamese MIG force, was made explicit on 28 January 1970, when a MIG shot down a Jolly Green rescue helicopter on the Laotian Border.

Within North Vietnam, an integrated air defense system had been produced during the years the air war was focused there. The SA-2 GUIDELINE SAM had seemed to be a particularly formidable addition to the defense inventory when it first appeared in 1965. But during the subsequent three years of intense aerial combat, USAF aircrews were provided electronic equipment to detect launches of the missiles and to degrade the performance of various enemy radars, including those associated with the SAMs. More important, aircrews had learned that if they could see the missile early enough, they could outmaneuver it. During the period of this report, while SAMs were fired at several USAF aircraft and shot down several drones, the USAF lost no manned aircraft to the missile.^{12/} The most significant change in the SAM threat was neither in tactics nor in total numbers, but in the deployment pattern.

At the time of the bombing halt in November 1968, there were 191 prepared SAM sites in North Vietnam, with about 40 occupied. Of these, 7 were in the panhandle, but far enough from the border that they provided no significant coverage of Laotian airspace. Although some sites were abandoned and new sites were prepared, the total number of prepared sites changed very little. At the end of May 1970, there were 187 positions. The occupied positions, however, changed continually. By

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February 1969, missiles had been removed from all sites in the panhandle south of Vinh, apparently being added to the defense of Hanoi and Haiphong. The North Vietnamese had learned the SAM was not effective when spread too thinly; multiple firings, made possible by clustered sites and more firing units in each site, appeared more profitable.^{13/} Then at the end of 1969, SAMs were returned to the panhandle, this time with significant coverage across the Laotian Border.

The first indication of their redeployment was sporadic interception of radar signals of a type usually associated with SAMs, emanating from the panhandle of North Vietnam. On 19 December 1969, two SAMs were fired at a cell of three B-52s bombing near Ban LaBoy. By 10 January 1970, photo reconnaissance and electronic intelligence had located three active sites in the southern tip of the panhandle, providing coverage into Laos about 5 NM at Ban Karai and 10 NM at Mu Gia Pass. Later in the month, a site appeared just north of Ban Karai, giving 15 NM coverage into Laos. In February, sites appeared near Barthelmy Pass, with coverage 13 NM into Laos. The withdrawal of SAM equipment from the area probably began in late March. After 29 April 1970, no SAM-associated equipment was noted in the southern panhandle, and the deployment pattern of February 1969 was reestablished.^{14/}

While the SAM order of battle remained relatively constant in numbers of missiles and sites from November 1968 through May 1970, the North Vietnamese steadily increased and improved their MIG force. At the time of the bombing halt, the North Vietnamese air order of battle listed

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111 MIG-15/17s and 38 MIG-21s, almost two-thirds of which were based in southern China. By May 1970, the total jet interceptor force had risen from 149 to 265 (140 MIG-15/17s, 31 MIG-19s, and 94 MIG-21s), less than half of which were based in China.^{15/} Of the four types, the MIG-19 had the best thrust-to-weight ratio and out-performed the others at low altitudes. At sea level, in combat configuration, it was rated at .98 mach. It was best suited for employment at low altitudes and in clear weather, as was the MIG-17. The MIG-21s, added since the bombing halt, were believed to be D/F models with all-weather interception capability and superior high-altitude performance. The MIG-19s and the MIG-21D/Fs significantly upgraded the quality of the force. There were also indications that nearly all aircraft still based in China would be moved to North Vietnam, further increasing the effective quantity of the force. The MIGs generally suffered from poor cockpit visibility and were consequently very dependent upon ground-controlled intercept (GCI) positioning. The MIG-21 pilot could not expect to see a fighter in a tail chase any farther than three miles.^{16/}

The requisite training with GCI sites increased after the bombing halt. At that time, several North Vietnamese pilots had proved they had "sufficient talent and experience to pull 'Gs' with the best" USAF pilots. Further, the opportunity for extensive training afforded by the ending of U.S. strikes in the northern part of North Vietnam where training facilities were located, coupled with continual rotation of USAF pilots, could only improve the relative combat efficiency of the MIG force.^{17/}

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While increasing the number of interceptors and training sorties, the North Vietnamese rehabilitated and expanded their airfields. In the southern panhandle, Vinh and Dong Hoi were the only bases that could support jet traffic, and these had been kept unusable by continued airstrikes. With the end of the bombing, repair crews were soon at work on Vinh and MIGs were photographed there on 12 January 1970. Sixteen days later, a MIG-21 from that field shot down a Jolly Green helicopter on the Laotian Border.^{18/} The USAF lost no other manned aircraft to MIGs.

In summary, the threat faced by USAF aircraft in Southeast Asia varied within the three states where aerial combat occurred. In South Vietnam, small arms, automatic weapons, and some light AAA exacted a small but relatively constant toll. Those weapons, plus larger caliber guns, were also deployed in Laos, where the total number of guns increased almost 400 percent during the period. The gun defenses along the North Vietnamese frontier and major transportation routes leading south were intensified, as more guns, especially of larger calibers, and more capable gun crews appeared. The threat of SAMs and MIGs spilled over the border into Laos, but by the end of the period the SAMs had been pulled back. In North Vietnam, the gun inventory may have been reduced to provide guns for Laos. The inventory of prepared SAM sites remained almost constant, but for five months, sites were active along the Laotian frontier. The MIG force was doubled, the airbase complex was extended and improved, and training benefited from the slowdown in U.S. air activity over North Vietnam.

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CHAPTER II

TACTICS IN SOUTH VIETNAM

No matter how skilled and imaginative the fighter-bomber pilot in the Republic of Vietnam might be, he was required to operate under certain unchanging constraints. To deliver his ordnance, he had to fly within range of automatic weapons and any existing light AAA. These weapons were seldom pinpointed in advance--intelligence supplied little more than a general evaluation of the nature of the threat in specific areas. Through flight planning, some of these areas were avoided, but often the targets appeared in the area of highest threat. Certain ordnance and targets required a descent into the envelope of small arms fire. Again, areas of intense small arms fire could be identified, but the weapons would be completely mobile, seldom seen from the air, even when firing. Enemy infantrymen ordinarily were exempt from retaliatory flak suppression and therefore felt free to fire with impunity.

A pilot could generally improve his accuracy by flying lower and slower and tracking the target longer, but these maneuvers exposed himself to greater risks. The priority of the target and the necessity for achieving a given degree of accuracy had to be balanced against the risk involved. Because defenses were almost never known with precision and in advance, the decision could seldom be made on the ground. The flight leader could not be expected to understand the ramifications of every strike, especially one against a target that was not pre-briefed;

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but he was the on-scene commander and had to make the final decision and act on it. For some targets, the decision was obvious. In a rescue operation, or supporting troops in contact with the enemy, extreme risks were justified. Likewise, if a gun had to be destroyed to get to a specified target, failure to do so meant that someone else had to go "down the chute" exposing additional aircraft and crews needlessly. For ^{1/} the great majority of targets, however, the decision was not so simple.

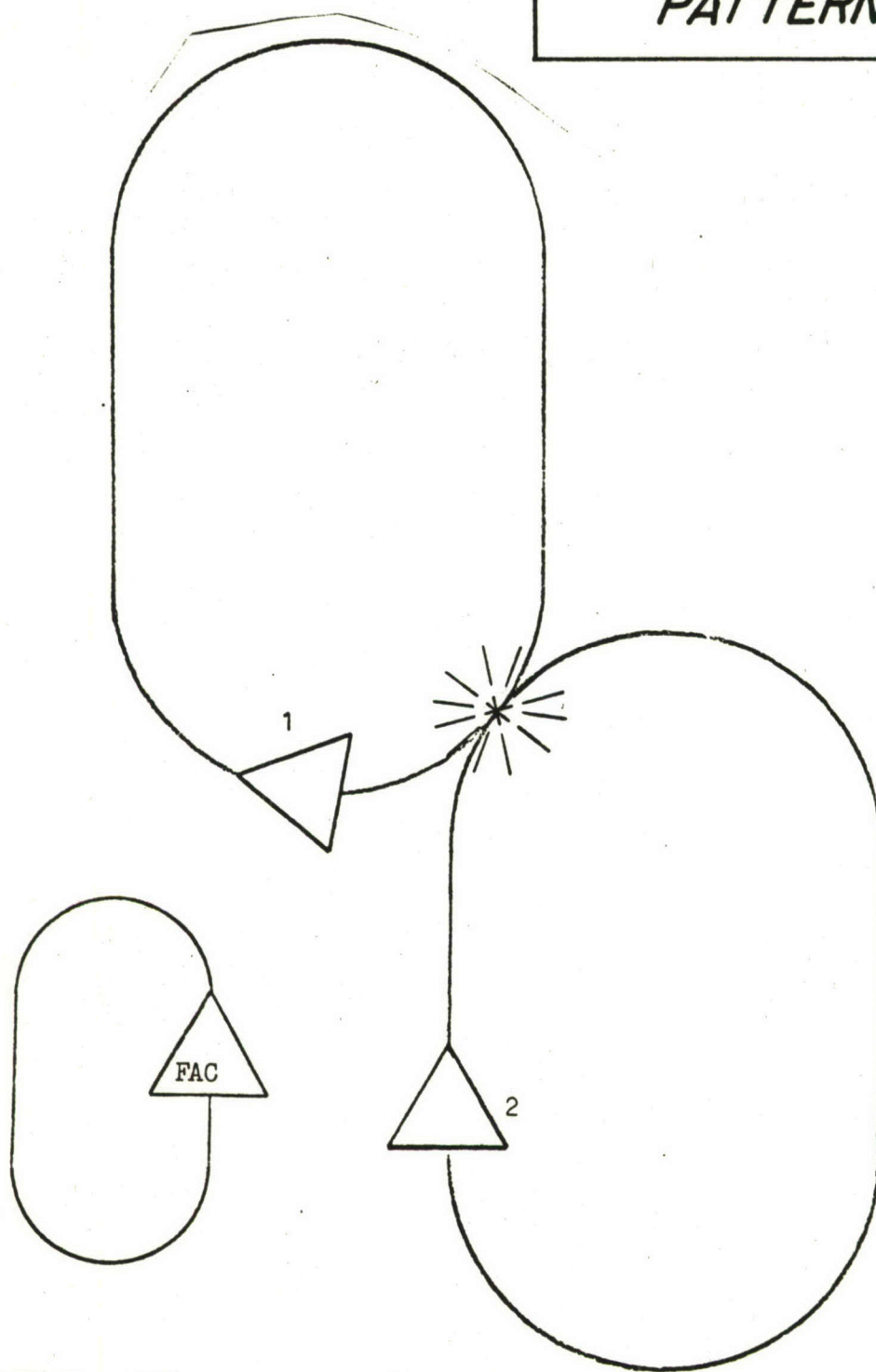
The flight leader could choose from five basic patterns to deliver ordnance against ground targets. The simplest was the racetrack or box, with each attack delivered in the same direction, each recovery in the same direction, each aircraft keeping its place in line. Every pilot knew it well, for it was the standard pattern used on training ranges. It was the simplest for attack pilots, forward air controllers (FACs)--and enemy gunners. It was therefore the most dangerous pattern for combat use, but sometimes pilots were forced into it by the nature of the target, terrain, or weather. More often, when a target did not seem to be defended, pilots used the racetrack pattern through complacency. ^{2/}
^{3/}
An F-100 pilot wrote:

"Every type attack aircraft in country can be observed doing it. And the reason, of course, is that a random attack is more demanding on the attack pilots and the FAC....Following the leader relieves much of this burden because everyone is predictable even to enemy gunners."

When attacks had to be delivered along a single axis--one direction

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*OPPOSING BOX
PATTERN*



SOURCE: 8TFWM 3-1, Aug 69, p. 5-124.

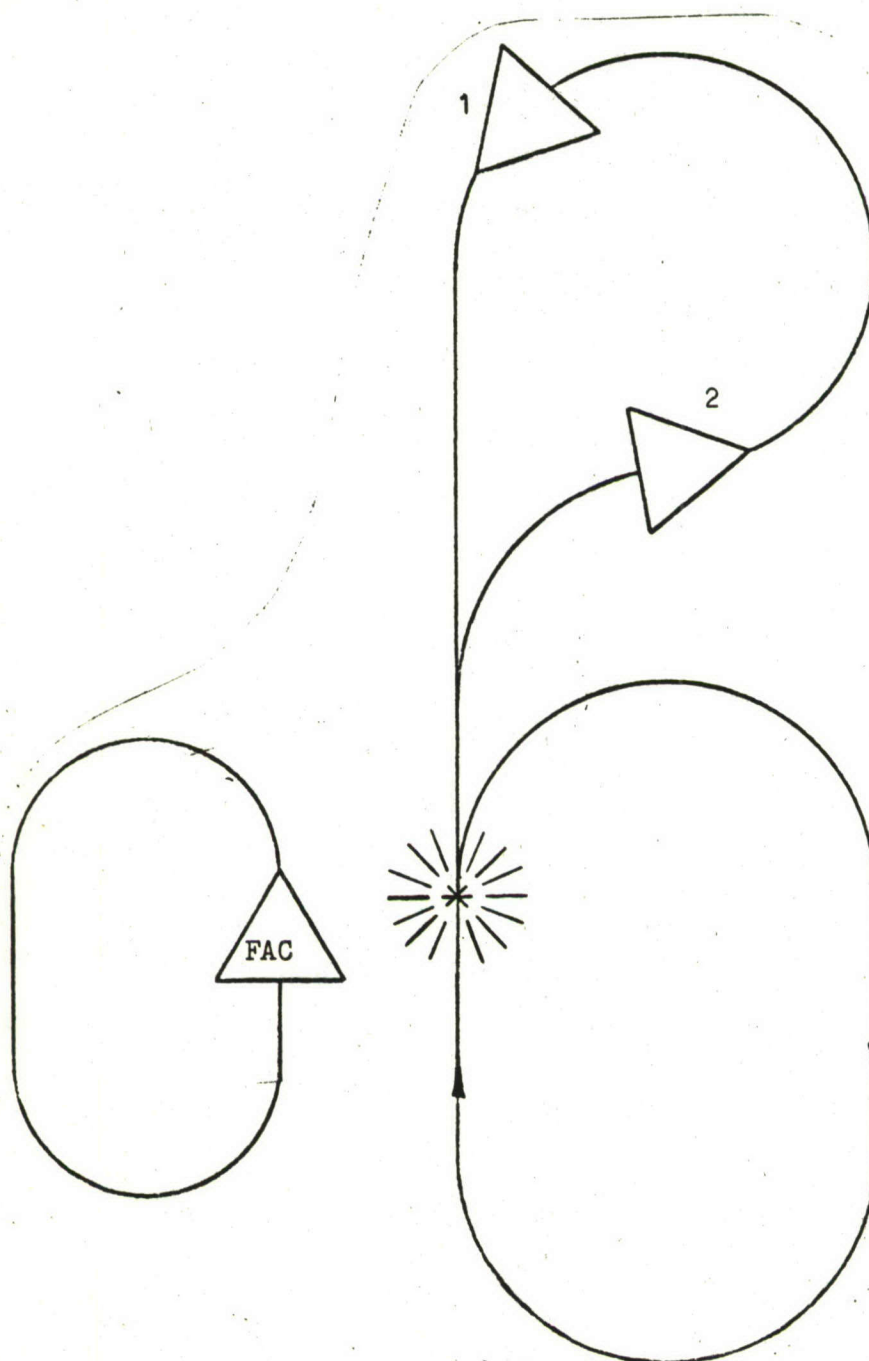
FIGURE 3

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90° - 270°
REVERSAL



SOURCE: 8TFWM 3-1, Aug 69, p. 5-126.

FIGURE 4

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and its reciprocal--as was normally the case when supporting troops in contact, two patterns were possible. If aircraft were not restricted as to the area in which they could fly, the opposing box pattern (Fig. 3) could be used. As illustrated, the FAC was guaranteed a quadrant to himself, close enough to observe the results, and gunners had to contend alternately with attacks from two directions. If pilots were denied the use of airspace on one side of the attack axis, as occurred regularly along the Cambodian frontier, the 90°-270° reversal (Fig. 4) could be flown, but the FAC might be squeezed into a narrow corridor.^{4/}

When there were no restrictions on the direction of attacks, the floating wheel (Fig. 5) was possible. This pattern provided complete flexibility in headings and sequence of attacks, because any aircraft could roll-in at any time, the wheel providing a continuous base leg. But the pilots had to coordinate varied sequencing closely, with radio calls of direction in and direction off the target on every pass. Otherwise random sequencing and varied headings might confuse the flight more than the enemy. Because all aircraft orbited in the same direction in the floating wheel, ground gunners benefited by always tracking in a constant direction. This advantage could be denied them by using the last pattern, the cloverleaf (Fig. 6). With more than two aircraft in the attack flight, or more than two elements flying formation, the cloverleaf was difficult to use and invited mid-air collisions. Neither

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the floating wheel nor the cloverleaf reserved a space for the FAC, and these patterns were more easily used when a FAC was not required.^{5/}

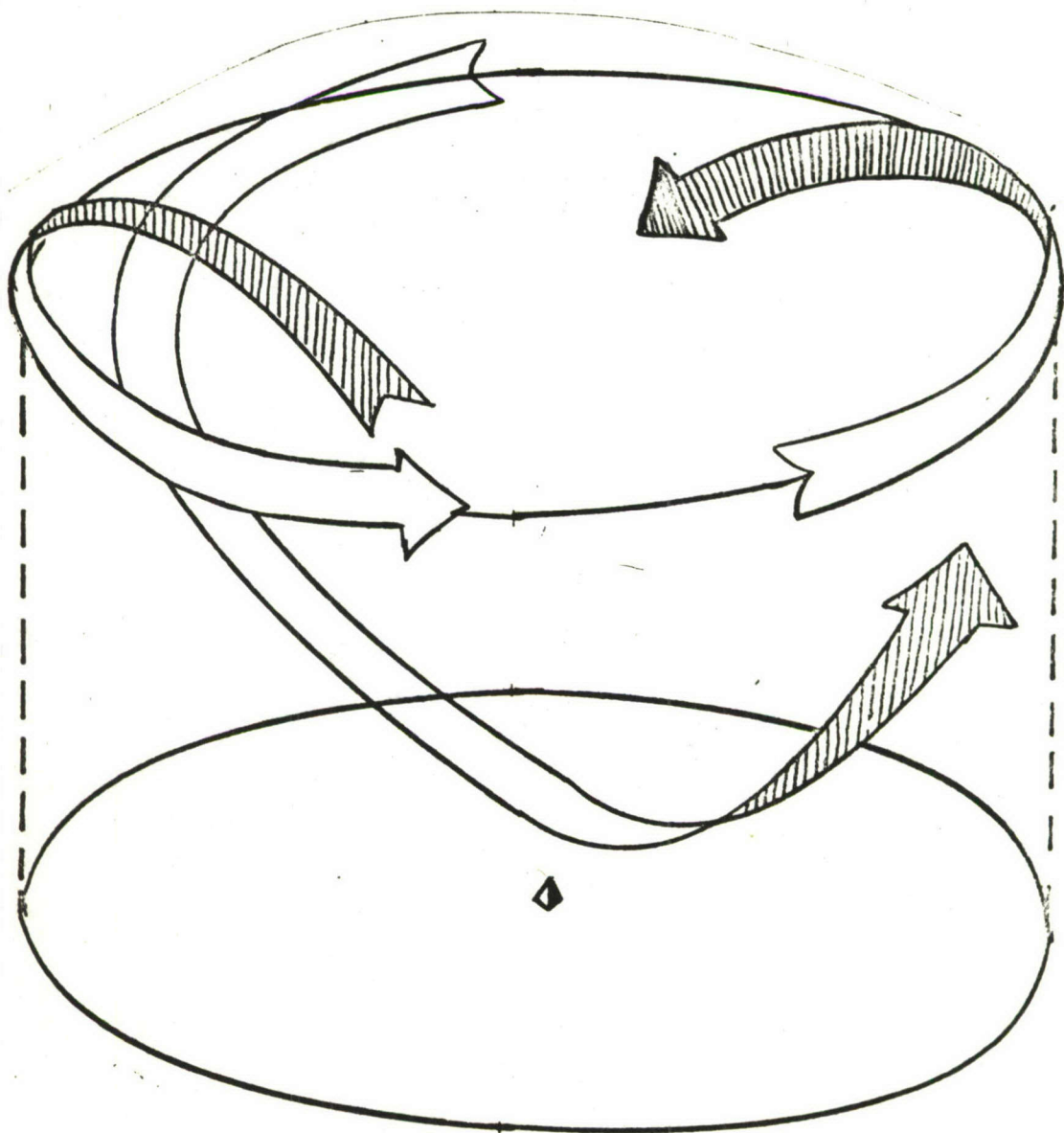
No matter which pattern was used, the attack aircraft was vulnerable to small arms and automatic weapons during the delivery pass and release. Habits gained on the training range had to be overcome to avoid unnecessary risk in combat. In Southeast Asia, new pilots were taught--and old pilots were reminded--in tactics conferences and manuals to strive for a curvilinear approach at high speed, with the aircraft moving in all dimensions, until the last possible moment when the wings had to be leveled and the target tracked. The most common faults of newly assigned aircrews during pull-up from the target were excessive Gs, turning the aircraft before the nose passed through the horizon and getting the nose too high, causing excessive loss of airspeed and ability to regain altitude. During pull-up and escape when the aircraft was even more vulnerable, pilots were to move the aircraft immediately from the flight path predicted by the gunners, get the nose above the horizon as quickly as possible, and prevent the airspeed from dropping so low that the aircraft could not maneuver easily during the climb out. Again, following the same flight path during every recovery played into the gunners' hands. No two succeeding pilots were to make the same evasive maneuvers. The crutches that trainees learned to depend on for accuracy and safety on the range had to be unlearned; this was "the most difficult adjustment for individuals entering a combat environment for the first time."^{6/}

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FLOATING WHEEL



SOURCE: 8TFWM 3-1, Aug 69, p. 5-127.

FIGURE 5

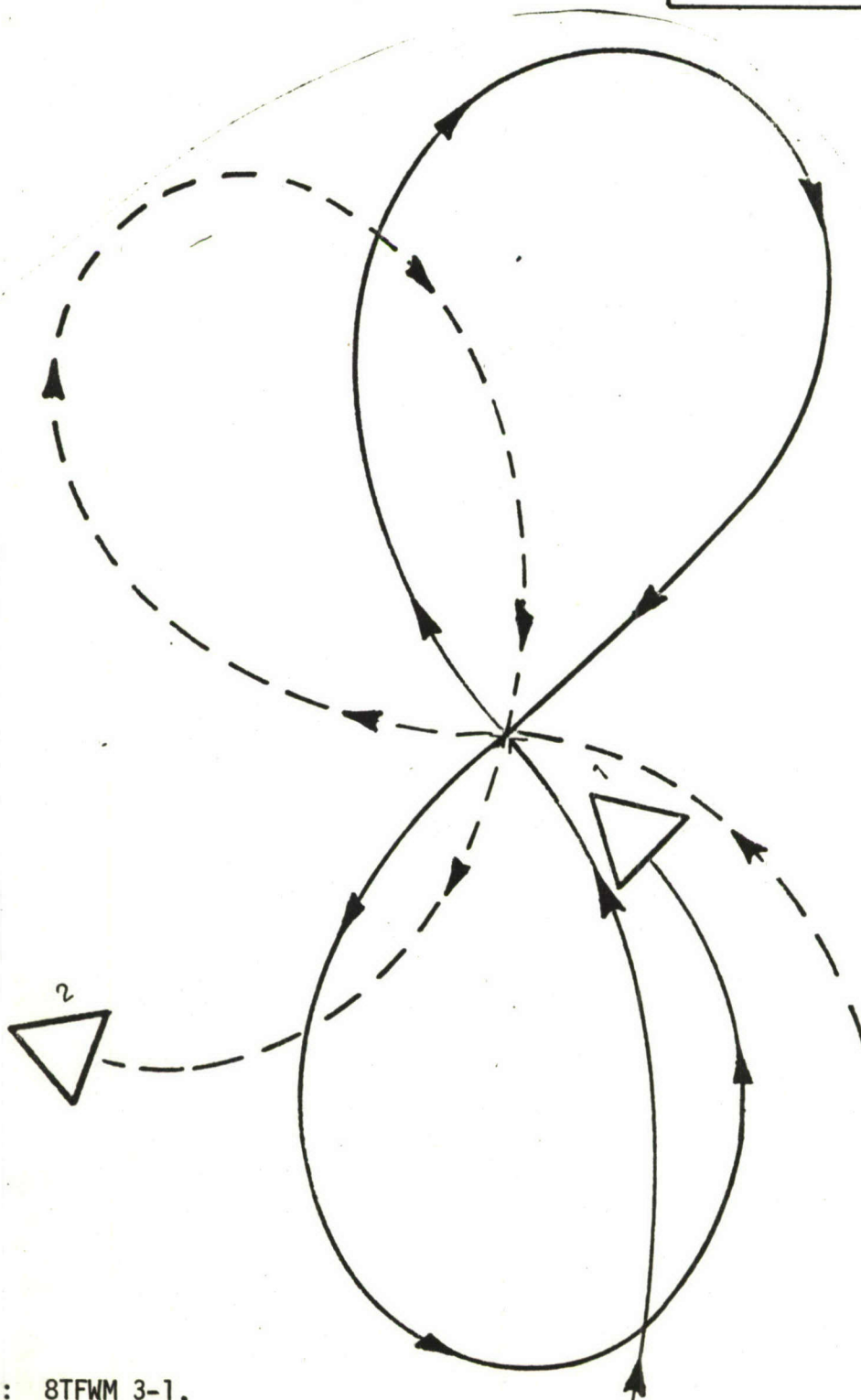
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CLOVERLEAF
PATTERN



SOURCE: 8TFWM 3-1,
Aug 69, p. 5-129.

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FIGURE 6

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Determining the number of passes to make and the timing between successive passes again required the flight leader to balance required results against potential risk. Obviously, a single pass exposed an aircraft to fire less than several passes. Of more importance, however, was the advantage gained by the gunners as passes continued. They could get set for the attack, observe the aerial tactics, and adjust their procedures accordingly. With successive passes, ground fire tended to become more accurate, but some ordnance required multiple passes, as did certain targets. Generally, with a given ordnance load, multiple passes produced more effect than dropping everything on a single pass.^{7/}

The ideal timing between successive passes, considering only the threat of enemy guns, was zero. However, the dangers of mid-air collision and of flying through ordnance of the previous aircraft dictated a few seconds' delay. Further, the FAC had to have time to give corrections based on the previous impact; otherwise good ordnance might be thrown after bad. Accordingly, the flight leader had to seek yet another compromise.^{8/}

The cockpit of a fighter-bomber in combat is scarcely an environment conducive to the judicious weighing of so many alternatives--as indicated before, the data for precise calculation were often lacking. Further, there was potential dilemma here, seldom mentioned explicitly but nonetheless real. How could the fighter pilot, who had to be aggressive, retain that spirit if he continually had to make defensive calculations?

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Two resources were available to mitigate the difficulty. One was the pilot's own professionalism, experience, and maturity. The other rested on command guidance, such as minimum altitudes and maximum numbers of passes for specified targets and missions. By such rules, commanders simplified the problem for the man in the air, while enhancing their control of operations. The rules varied from time to time and from unit to unit, as commanders reassessed the general threat and the relative necessity for force conservation in an ever-changing tactical situation.^{9/}

If no magic solutions to the problem of protecting strike aircraft from ground defenses were discovered, a number of old axioms, some dating from World War I, were revalidated. Attacking out of or recovering into the sun hampered gunners. When attacks could be flown toward safe areas, with enough speed to clear the target area, the crew had a potential advantage. Even when no hostile aircraft were involved, pilots learned to set their mirrors and scan the area behind the aircraft, because ground gunners often simplified their tracking problems by sweeping through the formation from the rear. Aircraft not attacking watched for gun flashes and rolled-in on the gun, if flak suppression were required. Flying just beneath an overcast was dangerous, because the gunners used the cloud height as an altitude reference. No matter how successful tactics were, if a unit continued to do things the same way, the enemy devised effective countermeasures. Tactics therefore had to

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be changed often. The same argument was used against excessive standardization: "There was a consensus that too much standardization would increase combat losses by making the enemy gunners' job easier." On leaving the target, careful checking for battle damage avoided unpleasant surprises in the landing pattern. Other axioms related to night operations: flying against the moon was asking for trouble, and flying blacked out hampered the enemy gunner but heightened the risk of mid-air collisions. The speed advantage of the afterburner often had to be sacrificed: it was too easy to track. Likewise, high-angle dives, while safer against the gun threat, increased the likelihood of flying into the ground at night. In fact, the hazards of attacking under flares, with the rapid transition from darkness into the brilliance of the flare and back into darkness, with no horizon and inadequate spatial references on the surface, often required a pilot to forget the ground defenses and concentrate on an instrument recovery.^{10/}

Surprise remained a priceless military commodity, and tactics were designed to protect it. An incautious FAC could destroy the advantage of surprise by orbiting a target too ostentatiously or by marking it too early. The strike flight could do so by arriving at the target unprepared for an immediate attack, for example, with excessive fuel. If the FAC and the strike crews coordinated carefully, completing the briefing while the strike flight approached the target and marking the target at the last moment (or sometimes not at all), maximum surprise resulted.

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Sometimes multiple marks were put down, to confuse the enemy as to the intended target. This of course could, if carelessly used, mislead the strike pilots. Gunners often waited until the strike flight started strafing before opening up; retention of a bomb or two could disrupt this tactic. Likewise, if a flight left attack formation and rejoined over the target, every gun in the area could be expected to open against them. Finally, if a wingman had to fly cover for a downed crew, he had to remember that needless circling exactly over the downed crew advertised the position to the enemy. If the position were known and enemy forces approached the downed man, suppression passes had to be put in, of course, and prudent pilots reserved a few rounds for this contingency. After expending all ordnance, deception still could be used to advantage: dry passes sometimes bought valued time, until a relieving aircraft arrived with ordnance. ^{11/}

Some of these maneuvers may have seemed old hat, but the war in Southeast Asia generated unique missions. One of these, flown frequently in South Vietnam, was defoliation. UC-123s, rigged with the requisite plumbing, sprayed herbicide over stretches of tropical vegetation. Since the purpose of defoliation was usually to expose hostile troops and the UC-123 flew at 100-150 feet above the ground at 140 knots, these missions could be extremely risky, and armed escort was provided. In a low threat area, two fighters went along "to let the enemy know that retaliatory fire was immediately available if he fired on the spray aircraft. The fighters were advertising their presence; this...proved to be a very

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effective tactic to discourage ground fire." The fighters attempted to maneuver so that one of them was in front of the leading spray aircraft all the time, and as close as possible. Yet if their jet wash disturbed the spray pattern, some vegetation would not be killed. Worse, pilots of subsequent UC-123s would find themselves on instruments, their windshields covered with lead's viscous, oil-based herbicide. When ground fire was noticed, the spray crews or the FAC marked it for later attack, after the spray aircraft had climbed to a safe altitude and departed the area.^{12/}

For spray missions in known high-threat areas, at least four fighters were provided. If smoke were to be used, CBU-12, fused for an air burst at 300 feet, was laid down two minutes before the spray aircraft arrived. Flak suppression was provided by an element dropping CBU-24, delivered so that the bomblets impacted 45 seconds in front of the spray leader. A second element, armed with guns, split and strafed along lines parallel to the spray track. The purpose was "to make as much noise as possible and to get the enemy into his bunker." With the wide variance in airspeeds and the critical timing requirements, a common briefing of the FAC, the leader of the UC-123 formation, and the leader of each escort element was found essential.^{13/}

With the exception of those associated with herbicide missions, nearly all tactics used against ground defenses in South Vietnam were old, tried-and-true methods. The development of new tactics was made more difficult by the continual rotation of pilots through the theater,

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which gave the combat commanders a training requirement of unusual proportions. If some apparent wheel-spinning resulted, it is appropriate to note that the large numbers of new pilots were integrated into the fighting force, successfully honed for combat.

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CHAPTER III

TACTICS IN LAOS

Nearly all combat missions flown in Laos--forward air control, strike, reconnaissance--were similar to those flown in South Vietnam. The level of air operations and tactics employed in South Vietnam were essentially static, while in Laos, the rapidly increasing level of air operations was answered by a rapid buildup of enemy defenses. Tactics employed by both sides also showed an action-reaction pattern. In northern Laos, the USAF supported ground forces and also attacked interdiction targets.^{1/} A considerably greater effort was flown in southern Laos, where friendly ground forces usually were not involved. In two concentrated campaigns during the dry seasons of 1968-1969 and 1969-1970, the USAF disrupted the flow of supplies along the roads and waterways of the Ho Chi Minh Trail from North Vietnam to South Vietnam by cutting lines of communications, destroying supplies, and especially by killing trucks. This interdiction involved reconnaissance of the same roads day and night and continued strikes in a few constricted areas.^{2/} As ground defenses increased in quantity and quality, aircrews were forced to use every conceivable defensive tactic to survive and accomplish their missions.

There were no magic answers to surviving over the well-defended targets in Laos. Rather, aircrews used the same tactics employed in high-threat areas of South Vietnam, but they applied them more

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conscientiously. Jinking (changing heading and altitude) was universally recognized as a means of avoiding aimed fire. In Laos, pilots learned from experience that kicking the rudders or wagging the wings was insufficient. Positive and abrupt changes had to be made, and in a random pattern. One rule of thumb, based on the time required for a shell to reach the altitude of the airplane was for the jinking interval in seconds to be two-thirds of the altitude in thousands of feet. For 15,000 feet this was 10 seconds; for 3,000 feet, two seconds. Pilots could not watch the clock; but they knew that the lower they were, the more frequently they had to jink. Visual reconnaissance along roads was extremely hazardous during daylight, but it sometimes had to be done. The aircrews could not afford straight and level flight, even for short periods. For the F-4, this was not the inconvenience it might appear, because this aircraft had to be flown in a continuous bank. The aircraft commander gave most of his attention to looking forward, avoiding obstacles, which left most of the reconnaissance effort to the Guy in Back (GIB), who could not see over the engine intakes unless the aircraft were in a bank. Continuously carrying high G-loads in hard turns and altitude changes tended to erode airspeed, which could not be tolerated in high-threat areas. Against barrage fire, where jinking merely extended the time the aircraft was exposed, the best defense was high speed. Power settings therefore had to remain high, with resultant high fuel flow, reduced time on target, and frequent trips to tankers.^{3/}

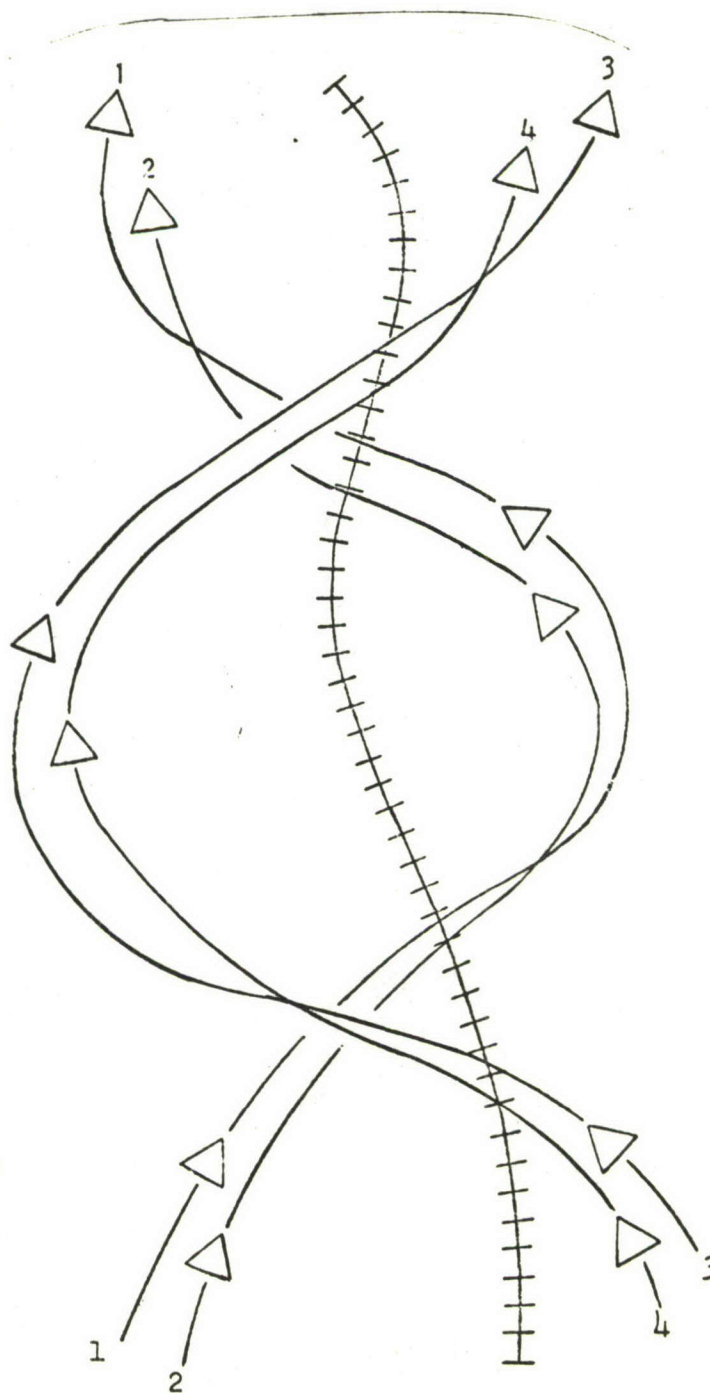
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**ARMED RECONNAISSANCE
FORMATION
FOUR AIRCRAFT**



SOURCE: 8TFWM 3-1, Aug 69, p. 5-31.

FIGURE 7

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In delivering ordnance, the recovery from the dive remained the most critical phase of the maneuver. When barrage fire from automatic weapons was the main threat, it was most important for the aircrew to hold the minimum altitude as high as possible by getting the nose above the horizon immediately after weapons release. When the main threat was accurately aimed fire from larger guns, some pilots believed it was even more critical to disrupt the gunners' prediction of the flight path by moving the aircraft off the release heading. But dropping a wing before the nose came through the horizon was hazardous; it increased the time spent within range of automatic weapons, which were almost always found with the larger guns.^{4/}

Even maximum jinking left forward air controllers and armed reconnaissance flights terribly exposed when they had to fly back and forth along assigned road segments. Crisscrossing along the road by a series of S-turns allowed the crews to keep the road in sight while giving gunners the maximum tracking difficulties. Figure 7 shows a preferred pattern for armed reconnaissance by a flight of four operating in two elements. It was important that the two elements, and the two aircraft in each element, avoid crossing the road at the same point, because doing so effectively gave the gunners the easier problem of two aircraft in trail. The second man could expect a hot reception. Once the defenses at a particular point had been thoroughly aroused, it was safer to go to an alternate target for a while, returning to the first area after it had cooled down. When the purpose was only bomb damage assessment, this was mere prudence. If the purpose were a second strike, leaving the area

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for a while gave an additional benefit: road repair crews might have returned to their work or trucks might have come out of the trees and resumed their journey. To maintain round-the-clock pressure on the lines of communications, certain critical points were kept illuminated by flares all night. Dropping the flares taxed the ingenuity of the aircrews, because no matter how carefully they jinked and varied their run-in headings, a particular point was going to be flared about every five minutes, and the gunners soon caught on. Constant turns around the flare, or flying between it and the guns, invited trouble. Instead aircrews made short passes across the fringes of flare light, not attempting to see more than a short road segment or a single point on each pass.^{5/}

The slower, unarmed forward air control aircraft used at night, such as the C-123 and O-2, usually found that darkness gave sufficient protection without excessive jinking. Because guns were frequently deployed in two lines roughly parallel to a road, the FAC could halve his exposure by flying on one side of the road, rather than over it. When working with strike aircraft, it was in the best interests of the FAC to avoid areas where he would receive fire meant for the strike ship.^{6/}

Flying blacked-out was an obvious requirement, and posed no difficulties when a single aircraft operated in an assigned area. Exterior lights were extinguished when over hostile ground and interior lights were turned as low as the aircrew could tolerate. Lights on unneeded

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instruments were masked with tape. But when a FAC and strike aircraft worked together, and when strike aircraft were fraggged in flights of two or more, the hazards of mid-air collision had to be considered, and some crews chose to use exterior lights. Generally, lights visible only from above were safe, either panelescent lights on the fighters or the shielded, rotating beacon on the slow FAC. Flame suppressors were installed on the C-123, when available. Aircraft bottoms were painted black. Even with minimum lighting and maximum coordination by radio, as the airspace above the limited number of interdiction targets became saturated by airplanes, some crews worried more about mid-air^{7/} than enemy defenses.

Photo reconnaissance aircraft had peculiar problems evading ground defenses. Oblique camaras had been designed to allow photography from a safe distance, but the heavy tree cover in Laos usually required vertical photography for usable intelligence. The characteristics of the cameras and film, plus the required coverage, dictated the profile of the aircraft while on a photo run. Day photo runs in the RF-4C were usually flown at 4,500 feet above the ground (9,000 feet for stereo), with wings level, and moderate altitude changes and acceleration up to the limits of the cameras. Cutting the required coverage of a road into short segments and flying the segments at different times effectively reduced exposure to AAA. At night, infrared and laser sensors were used almost exclusively. Even three flash cartridges, the minimum

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practical for photography of any target, made the path of the aircraft painfully obvious. A sharp change in course just before the final target heading helped to mislead the enemy.^{8/} The 432TRW experimented with flights of two aircraft in a dual FAC/reconnaissance role, one equipped with marking rockets and 20-mm cannon with tracer, the other with cameras and other appropriate sensors. The aircraft searched an assigned area, with one of them always holding high to watch for threats the lower crew might not see. Sometimes a photo run at a safe distance could be substituted for a low, visual pass. The crews also learned that studying their own pictures improved their ability to acquire targets at greater visual range, thereby reducing their exposure on subsequent missions. Another special mission was photographing the approach to a PAVE WAY target. This required a dive on the target from about 20,000 feet. The reconnaissance crews took too much ground fire because, presumably, they "looked like a strike coming down the chute." They found it to their advantage "not to look like a strike aircraft at any time." By developing a lower approach, they took several pictures quickly at the proper angle, and withdrew.^{9/}

To provide guidance to aircrews as to the degree of risk they should assume, minimum altitudes and the maximum number of passes at a given target were established. In November 1968, aircraft were generally restricted to a minimum altitude of 4,500 feet, even though this

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required the A-26 to release at 5,000 feet, which was beyond the limits of its bombsight. In January 1969, the Commander, Seventh Air Force, "to insure optimum effectiveness" canceled this restriction and gave wing commanders the responsibility for minimum altitudes.

The Commander of the 355th TFW, for example, immediately set 3,500 feet for dive bombing, except for point targets, where the minimum would be 2,500 feet, the same as for strafing. For the A-26s working in northern Laos, the minimum became 3,000 feet, except for rescue and troops-in-contact.^{10/} F-105 pilots of the 355th TFW were required to decide minimum altitudes and the maximum number of passes for themselves but were advised the desired release altitude was 7,000 feet. Further, "releasing lower than the planned altitude to correct for shallow dive angles was not acceptable," because of the threat of ground fire as well as the arming times on many of the weapons. The flight leader was told that he would "not be criticized for being too cautious. He might well be criticized for taking foolish chances against nonlucrative targets." The 8th TFW retained the 4,500-foot minimum for day deliveries in high-threat areas, and set a 1,000-foot minimum for low angle deliveries at night.^{11/} In January 1970, when the hit/loss rate for jet FACs was becoming excessive, the Seventh Air Force Director of Combat Operations restored the 4,500-foot minimum for that particular mission, telling the commanders concerned:^{12/}

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"...4,500 feet AGL seems to be the magic dividing line between lots of hits and no hits. I also realize that you can't see as much from that high. I am willing to accept the reduced VR effectiveness from 4,500 feet, because if we don't cut down losses and hits we may lose the program altogether."

The 460th TRW applied a similar kind of command guidance by dividing reconnaissance targets into priorities. Depending on the category, aircrews who received ground fire were to: continue the mission with maximum time separation between successive runs in the area; depart the area and return later to complete the run; or abort the mission. For visual reconnaissance in late 1969, they flew either below 500 feet or above 4,500 feet. The lower altitude was prohibited in early 1970.

Aircrews received aid in avoiding AAA from a new source in 1969-- the ubiquitous computer. Intelligence always provided the best known locations of guns, but the information changed continually and the number of locations of concern for a single mission could be very large. Plotting the threat areas manually was tedious and some crews did not bother to do so, particularly since they were subject to frequent diversion. The 39th Aerospace Rescue and Recovery Squadron (ARRS) and 31st Combat Support Group (CSG) collaborated to produce a computer program that would print out the previous day's (or week's) active gun sites and the

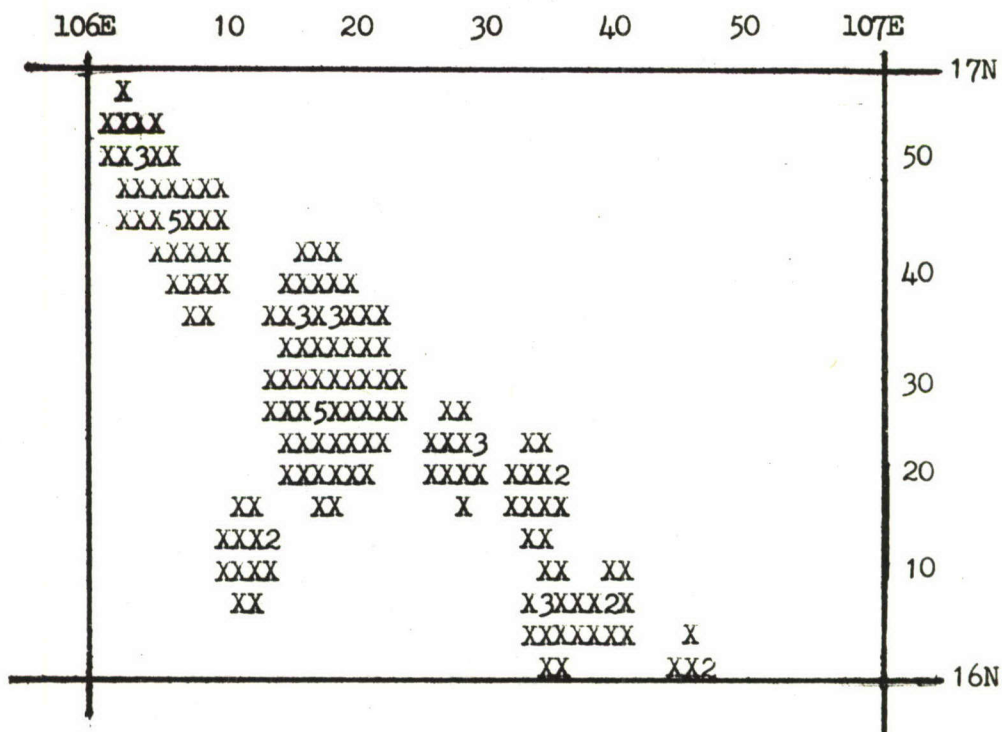
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COMPUTER PRINTOUT OF AAA COVERAGE



The number gives the location of the weapon.

Key: 2 . . . 23mm
3 . . . 37mm
5 . . . 57mm

SOURCE: WAIS 69-29, 19 Jul 69, p. 13.

FIGURE 8

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coverage of each weapon (Fig. 8). Used with a plastic map overlay, the coordinates were accurate within one-half mile. Printout time was about ten minutes. Rescue crews were using the computerized gun plotting by April and later it became available to other units. ^{13/}

Aircrews also noted that their ability to avoid AAA was related to their familiarity with an area and asked, more than once, that each wing be given a primary working area. Seventh Air Force recognized that this was desirable, but as the emphasis in the air war shifted from one place to another, the scheme was frequently impractical. ^{14/}

As the first interdiction campaign began to impair enemy strongholds, he responded with so many guns that evasion became more difficult and losses mounted. Further, stiff gunfire degraded the accuracy of ordnance deliveries. On 10 January 1969, in the same message that eliminated the 4,500-foot altitude limitation, the Commander, Seventh Air Force, directed that destruction of guns be given "the highest priority." Aircrews had attacked guns from time to time before, but starting in January, sorties were fraggged specifically for known gun positions; interdiction sorties were regularly loaded with mixed ordnance, including some for gun suppression; and attack aircraft generally operated as flights of two at night, four during the day, for mutual support against guns.

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During the second interdiction campaign, when the gun count had started high and risen higher, two special operations called "gun days," in which AAA targets were fragged for strikes, were flown in December 1969.

Doubling the number of strike aircraft in each formation was perhaps the most effective single step taken against ground defenses. Single aircraft had been able to suppress particularly bothersome guns by dropping area munitions (clusters of bomblets). A single pass could usually be planned so as to fly over the gun on base leg or downwind, before rolling-in on the primary target. This tactic could silence a gun long enough to complete the primary mission. If a single aircraft attempted a shoot-out with a gun, the advantage lay with the gun, because an aircraft flying directly at a gun was the simplest of all tracking problems. But several options were available when two aircraft teamed up against a gun. The second aircraft held at altitude, watching for ground fire, while the first aircraft attacked the target. When a gun opened, the high aircraft promptly struck it. Sometimes the mere threat of the second aircraft seemed to inhibit the gunners. If it did not, more subtle tactics were possible. One aircraft could feint, get the gun crew's attention, while the second aircraft attacked from the opposite direction. During daylight, with flights of four, one element held the "hammer" on the AAA while the second attacked the target. The attacking element could reduce effectiveness of the fire they received by approaching the roll-in point in trail, with number two delaying his

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roll-in a few seconds. The gun crew then faced two aircraft attacking almost simultaneously but on different bearings and usually concentrated on one, thereby giving the other a better chance for accuracy. ^{16/}

Sorties fragged against known gun positions often arrived at their targets to find the positions empty, and destroying empty positions was scarcely worth the effort. Furthermore, destroying a gun in an earthen revetment was difficult. Iron bombs would do it, but almost direct hits were required, "a difficult proposition at best." On the other hand, suppression was relatively easy to accomplish with area weapons. CBU-24/49 bomblets did not require precise delivery, frequently killed or disabled the crews, and kept uninjured crews under cover. This suppression, however, was only temporary. The guns survived and surviving gunners gained experience for another day. The ideal solution was to use both types of ordnance in succession--CBU to silence the gun, then hard ordnance to destroy it--but this complicated the ordnance loading and required repeated passes, with exposure to adjacent guns in heavily defended areas. And of course, the precise location had to be known, and this was generally possible only after offering the guns targets to shoot at. ^{17/}

Locating the guns was always a problem in Laos. At night, the muzzle flashes and tracers were easily seen, but the tracers started burning some distance from the barrel and if the gun stopped firing before an aircraft was in position to strike it, the aircrews might

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have only an approximate position to shoot at. The FAC was frequently the key man in gun hunting, because he was more familiar with the area. According to Lt. Col. Norman G. Smith, in his End of Tour Report: ^{18/}

"Some fast mover FACs developed an outstanding ability to conduct an interdiction strike and keep one eye peeled for AAA. As soon as the first air burst appeared, they would make a pass at tree top level in the suspected gun-site area looking for the tell-tale wisp of smoke from the recently fired gun barrel."

Dust kicked up by the recoil might also give away the precise position. FACs were taught to turn hard into the gun when they were fired upon. This gave the gunner the hardest tracking problem while increasing the FAC's chances of spotting the gun. A second pass was usually required to mark the site, and with F-100s this was best delivered from a base altitude of 14,000 to 16,000 feet. After firing the smoke rocket at about 8,000 feet, a break away from the run-in heading and a high-G recovery, followed by a rudder reversal as the nose came through the horizon, allowed the FAC to note the impact and give an immediate correction to the strike flight. A-1 FACs in northern Laos used a "lateral stand-off" to mark active guns. While outside the range of the gun, they fired two smoke rockets in succession, to bracket the gun. The two impacts then provided references to talk the jets onto the target. ^{19/}

Three new weapons proved particularly effective against AAA. The PAVE WAY laser-guided bomb was used in quantity for the first time during

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the period of this report, while the electro-optical (television) guided PAVE WAY and the 500-pound ROCKEYE, a cluster of shaped-charge bomblets, received their combat evaluation.

The laser-guided PAVE WAY required two aircraft: one to illuminate the target with a laser beam, the other to drop the bomb while diving from a higher altitude, allowing it to enter the conical area into which its guidance system could detect the reflected laser energy. For the optimum release at 12,000 feet, the delivery aircraft rolled-in at 18,000 feet. Successful releases were made as low as 6,000 feet. At release, the carrier's task was finished, but the target had to be illuminated until weapon impact. The illuminator therefore flew a curved track about the target, preferably at 12,000 feet, and was exposed longer to hostile fire. Little evasive maneuvering was possible, because at 20,000 feet slant range, a change in bank angle of 1° displaced the center of the laser beam about 350 feet on the ground. The trained laser operator could, however, track through smooth maneuvers, and a slight nose-down attitude in the turn kept the aircraft changing altitude as well as heading without giving the operator an impossible task. The preferred operating altitude kept both aircraft above most of the AAA in Laos, and no aircraft was lost on a PAVE WAY mission. During the winter of 1969-1970, an average of one antiaircraft gun was destroyed for every four 2,000-pound laser-guided PAVE WAYs dropped; in the spring of 1970, this ratio improved to two guns for every three PAVE WAYs.^{20/}

The electro-optically-guided PAVE WAY eliminated the requirement

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for a second aircraft. The F-4 aircraft commander dived at the target; the GIB monitored the picture from the TV camera built into the nose of the bomb and locked the guidance system onto the target. When the aircraft commander confirmed lock-on, he released the bomb and pulled out of the dive. Operating altitudes were comparable to those used with the laser-guided weapon, and the delivery time was less. The electro-optically-guided PAVE WAY achieved remarkable accuracy during combat evaluation. Of 22 releases, there were 4 gross errors. For the remaining 18 bombs, the average circular error was 8.1 feet--close enough for a 2,000-pound bomb to destroy any AAA target. Neither guided bomb, however, was a panacea. Weather had to be excellent; neither laser nor television penetrated clouds or haze. The crews always had to be able to see the target. With the electro-optical system, night operations were impossible, and deep shadows sometimes protected targets during the day.^{21/}

The third new weapon, ROCKEYE, was an unguided bomb which opened in the airstream to dispense 247 bomblets weighing one and one-third pounds each. The bomblets were dual-fused, shaped charges. Against soft surfaces, such as earth, they exploded as ordinary fragmentation munitions. Against hard targets, they operated as shaped charges and would blow a small hole through eight and one-half inches of steel. Both were effective against AAA, the former against the crew and the latter against the gun. The aerodynamic characteristics of the bomblets gave a smooth distribution over an elliptical pattern of approximately 200 feet

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x 300 feet. Antiaircraft Artillery was the principal target during the combat evaluation. Bomb damage assessment was difficult as the shaped charge had no blast effect. A gun could be ruined by a small hole through the barrel, but the damage could not be detected from the air. Nevertheless, in every case where the gun was within the impact pattern of the bomblets, that gun ceased firing for the day. As with guided bombs, ROCKEYE was effective only against AAA sites that could be seen, but ROCKEYE also required the precise delivery conditions of the ordinary free-fall bomb.^{22/}

Even with the higher priority given guns, sorties fragged against AAA on special "gun days," revised tactics, and new munitions, the guns continued to take their toll in Laos. In the first interdiction campaign, the aircraft loss rate was nearly constant at .63/1,000 sorties, while the number of guns doubled. At the opening of the second campaign, losses rose alarmingly, reflecting both the larger number of guns and the large percentage of freshmen on the USAF team. For the entire campaign, the loss rate averaged .74/1,000 sorties. Without the special efforts to combat AAA, those loss rates would surely have been higher.^{23/}

The interdiction campaigns made use of a number of specialized devices, the delivery of which posed peculiar hazards for the aircrews. Acoustic and seismic sensors were placed along the critical roads in southern Laos to monitor traffic. The sensors varied in their ballistics and in the permissible release altitude. One type had to be released

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between 500 and 2,000 feet, a more dangerous zone than either higher or lower altitudes. The sensors, deployed in strings, had to be dropped from a wings-level attitude for precise emplacement. When more were required than a single aircraft could carry, formation delivery was essential; otherwise the second aircraft could never achieve the desired accuracy. The important roads were of course protected, and aircrews had to use every conceivable defensive tactic. They worked in conjunction with a FAC and attempted to make the mission look (and sound on radio) like an ordinary strike mission.^{24/}

Area denial munitions (antipersonnel mines delivered in clusters) were sowed to protect the sensors, but they were used in greater quantities to hamper work crews repairing road cuts. Because the number of suitable interdiction points was limited, the same places had to be seeded with mines almost daily, and achieving surprise became nearly impossible. The munitions for a time restricted the F-4 to 450 KCAS; this was later raised to 500 KCAS, but the aircrews would have preferred still higher limits. F-4 engines left a smoke trail that aided ground gunners. Afterburners suppressed the smoke, but holding the speed down while on a diving approach with the afterburners lit was a problem.

Flak suppression bomblets could be dropped only before the mines were delivered; otherwise many of the mines would be detonated. Crews worked without marker rockets whenever possible, occasionally asking the FAC to put down a false mark to mislead the gunners. Col. Slade Nash said in his End of Tour Report, "Flying through 'Rat Fink' Valley or the approaches to Mu Gia Pass at 500 feet with mines or area denial

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ordnance required considerable skill in placing weapons precisely on target and avoiding AAA."^{25/} Wingmen flew diversionary passes just before or concurrent with the actual delivery run. When two aircraft made a delivery in formation, it was essential that the pull-up headings be briefed. Consecutive passes were not attempted; the flight left the area for 15 to 20 minutes and then returned for a second pass. A-1 pilots called their procedure for delivering mines a "swoop." The formation went into trail and made the last power changes about 10 miles from the target, to prevent unnecessary warning to the gunners. Lt. Col. Norman G. Smith in his End of Tour Report said:^{26/}

"The FAC attempted to mark the start of the run at the same moment the A-1s rolled into a near-vertical approach with all aircraft jinking to avoid ground fire, followed by a rather abrupt recovery to place the lead aircraft over the start of the run in a level attitude 200 feet above the treetops....The run, which had to be conducted straight and level, lasted from 8 - 15 seconds and was the most vulnerable part of the strike."

To keep up the interdiction pressure during periods of bad weather, particularly during the wet monsoon, blind bombing was used. The MSQ-77 ground radar could control any aircraft for a blind bombing run. F-4s also bombed through the clouds using either their own radar or long-range navigation (LORAN). All three methods severely restricted the defensive maneuvering of the aircraft, and therefore exposed it to radar-controlled AAA. This potential threat did not materialize, except along the eastern border within range of guns in North Vietnam. Because the

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same interdiction points were struck repeatedly, however, enemy gunners began mounting barrage fire when they heard aircraft overhead. By January 1970, such fire "became intense and accurate due to the predictability of the stereotyped operations." The enemy also monitored air-to-air and air-to-ground communications. On one occasion, "a wingman reported that the flight was receiving flak at its nine o'clock position and the flak promptly walked through the formation to the three o'clock position." Secure voice communications equipment helped counter this threat.^{27/}

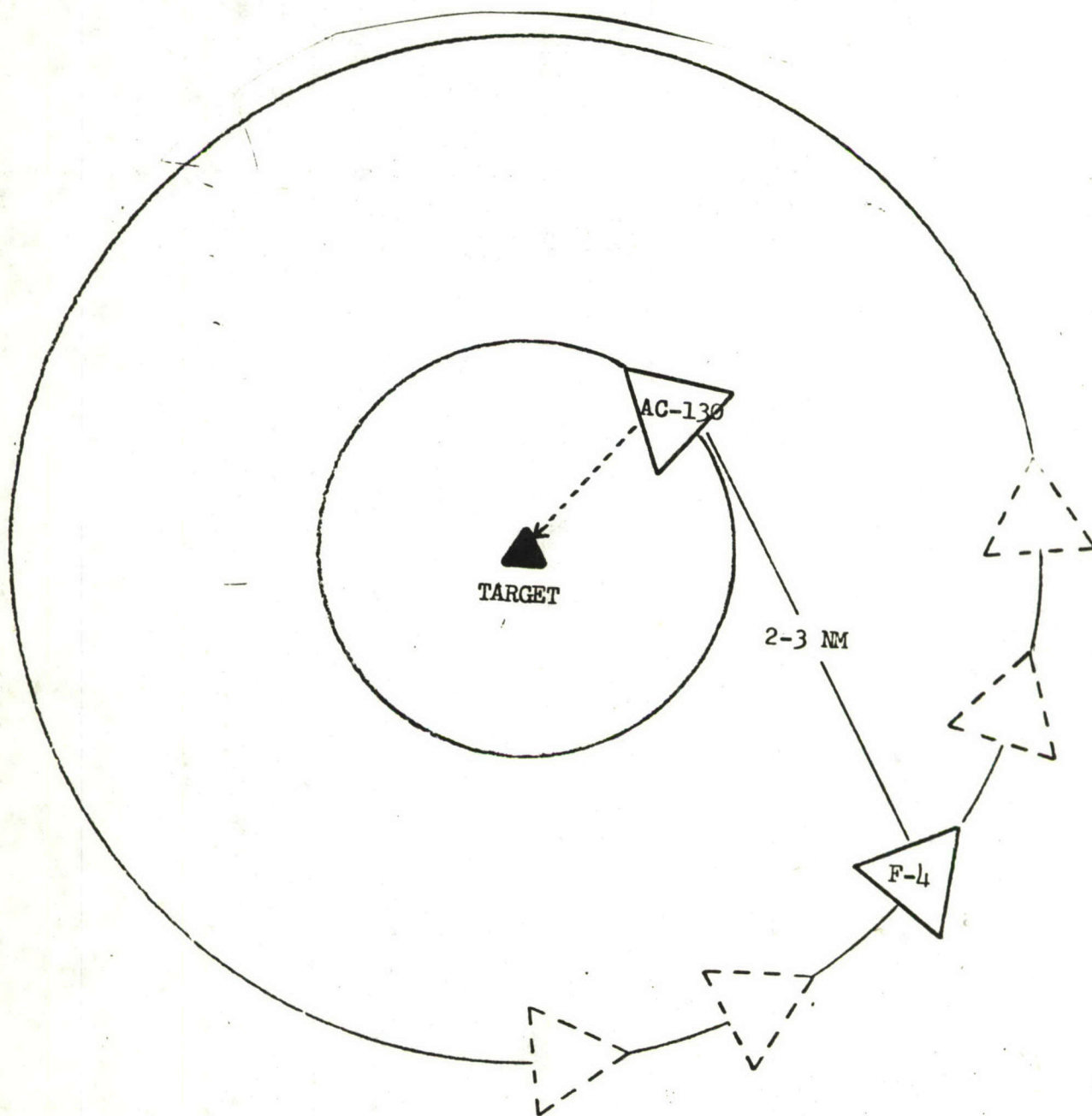
The development of aerial tactics against ground defenses in Laos can be illustrated with the AC-130. The gunship was first used against interdiction targets in relatively undefended areas. It was such an efficient truck killer that, as the AAA threat grew, the AC-130 worked closer and closer to known active guns. It was "not designed to shoot it out with multiple AAA batteries," however, and its principal tactic was to avoid the guns. This required accurate intelligence and careful plotting of known positions, as well as accurate navigation to stay out of the plotted threat areas. With practice, crews were able to work safely between guns located as close together as four - five miles. Crews also concentrated on accomplishing their tasks in a minimum time: acquire the target, roll into a firing orbit, fire, and roll out before completing more than 90°-120° of the orbit. During the full moon, gunships were not risked in high-threat areas. Finally an F-4 escort was provided.^{28/}

Escort tactics had to solve several problems. The intent was to

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GUNSHIP ESCORT POSITION



SOURCE: 8TFWM 3-1, Aug 69, p. 5-109.

FIGURE 9

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keep an F-4 flying at an airspeed that allowed easy maneuvering, positioned two - three miles behind and slightly above the 160-knot gunship, ready to attack any gun that opened fire. With the gunship flying a straight course, the fighter could hold position with an S-curve. But when the gunship entered a firing orbit, the fighter had to enter a larger orbit about the same point (Fig. 9). The radial speed of the gunships along its smaller circle exceeded the escort's, so that the latter had to periodically turn into the gunship's wake, allowing no smooth orbit. If for any reason the two aircraft became situated on the same side of the target, the gunship would be belly-up to the escorting pilot, who would be unable to see the rotating beacon on top of the AC-130. (The other external lights were of course extinguished.) If the F-4 could hold the turn briefly, however, the greater radial speed of the AC-130s would soon move it forward into the proper position again. The escort was therefore continually jockeying to retain, or regain, the preferred position. For one gunship to have continuous escort for three hours on station, three F-4s were fragged for staggered takeoffs. The fighters relieved each other about every 20-25 minutes, shuttling to a tanker for two or three refuelings during the mission. The escort needed to know the position of the gunship at all times, because in attacking a gun, the fighter passed through the gunship's altitude twice.^{29/}

F-4s also flew another escort mission. C-130s were used as night FACs in Laos, within range of MIG attack, and they were protected by combat air patrols. The variance in air speeds was again the principal

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problem for the escorts. A single F-4 could not stay in a position to ward off MIG attacks, so two were used, one above and one below the C-130. Splitting the element meant that the F-4s were themselves exposed, but there was no possible pattern that would give them mutual protection while also covering the C-130. When the fighters had to refuel, the C-130 left the exposed area until they returned. ^{30/}

One other, and quite different, escort mission was flown in Laos. A-1s escorted helicopters on sensor-dropping missions and when delivering or picking up ground teams in enemy territory. Two A-1s would escort up to five helicopters, providing gun suppression as needed. Over the landing zone, one A-1 orbited at about 1,000 feet, the second, wider and higher. As soon as ground fire appeared, the lower A-1 dropped wide-area, antipersonnel ordnance. The higher A-1, better able to see the source of fire, followed with accurate, forward-firing weapons. ^{31/}

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CHAPTER IV TACTICS IN NORTH VIETNAM

During the months of intense aerial combat over North Vietnam, the USAF developed a complex package, called a strike force, that was capable of penetrating the varied defenses and attacking targets there. The typical strike force consisted of 8-10 flights of 4 aircraft each. Within each flight, the aircraft and ordnance loading were homogeneous, but the force as a whole carried a wide variety of ordnance. CHECO Report, "Air Tactics Against NVN Air/Ground Defenses, December 1966 - 1 November 1968," described the evolution of the concept.^{1/} After the formal bombing halt, commanders were concerned that they might have to resume the mission, and their experienced flight crews were steadily being replaced by men who had never been exposed to the hazards of Thud Ridge. Strike forces were therefore employed from time to time, particularly against the high-threat areas along the Laotian-North Vietnamese Border. The strike force was also appropriate for some retaliatory attacks against North Vietnamese defenses that had fired on U.S. reconnaissance aircraft.

For passive defense against SAMs and radar-controlled guns, the strike force carried ECM pods and flew a formation designed to give mutually reinforcing protection. The pods contained two basic kinds of jamming equipment. Noise jammers, such as ALQ-71/87, transmitted continuously on the frequencies of anticipated ground radars, produced

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a continuous return and thus blanked out a two-degree sector of the scope. Additional jammers increased the total power, thus extending the effective range. They could also be separated in space to effect a wider angle on the ground scope. If spaced too far apart, however, the individual jammers produced a series of narrow strobes. Deception jammers, such as the QRC-335, retransmitted the signal of the ground station at frequent intervals, filling one azimuth with individual echoes at all ranges. Both kinds of jamming advertised the presence of a hostile force but denied the radar operator precise knowledge of position, speed, direction, and number of aircraft. Noise jamming of beacon frequency of the SAM interfered with the ability of the ground station to track its own missile. In all these cases, the best formation for maximum protection against a single, known radar could be computed, but that formation would change with the relative bearing of the radar. Additional radars further complicated the problem. Aircrews could not continually shift their formation, but a practical compromise would give near-maximum protection most of the time.^{2/}

One continuing difficulty raised by relying on ECM was that aircrews could not be assured of results achieved; it was similar to fighting in the dark. They had learned, however, that if they could see the SAM in time, they could outmaneuver it. For a very good reason, therefore, the optimum ECM formation was compromised still further. Stacking the formation up and away from the SAM site gave each crew the best

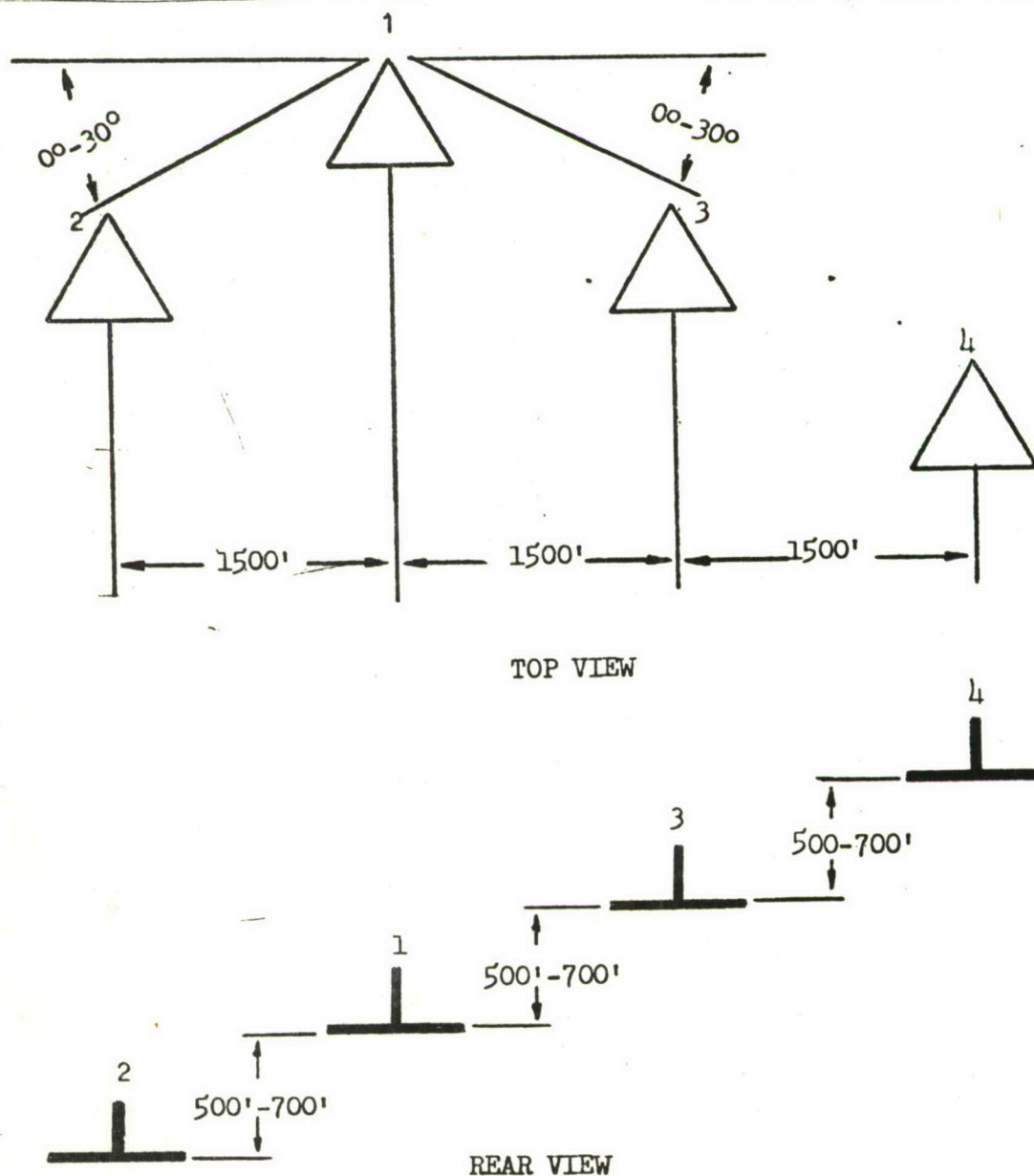
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STRIKE FLIGHT ECM POD FORMATION



SOURCE: 8TFWM 3-1, Aug 69, p. 5-20.

FIGURE 10

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chance for visual acquisition of missiles. The same change helped strike crews acquire their targets. The basic pod formation used by a strike flight within SAM coverage is shown in Figure 10. To provide enough time to see and evade a SAM, the aircraft had to stay at least 4,000 feet above an undercast. Crews received blunt advice on the subject: "Do not fly in clouds while in an area of known SAM sites. If you do, may you RIP."^{3/}

On seeing a SAM, the formation turned to position the missile at 9-10 or 2-3 o'clock, which presented the missile with its most difficult intercept, and pushed over into a dive. If the SAM followed the aircraft down, the flight executed a sharp, maximum-G pull-up when the missile was about 7,000 feet out. If this were done too early, the missile would be able to follow. Experience showed that pilots could estimate the distance accurately enough. Rolling out on the original heading and altitude, the aircrews looked for the next missile. If they allowed either their alertness or their airspeed to drop off, the second--or third--SAM could be deadly.^{4/}

Chaff was integrated into the ECM procedures, and if released at the start of the dive, gave the ground radar a good target to track and help delay response of the missile. It tended to draw fire, however, and further, crews could not use chaff if they were ahead of friendly aircraft. Random chaff often caused automatic tracking circuits to jump lock, forcing manual operation and degrading of accuracy. Chaff bursts at regular intervals, however, effectively marked the track of

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the aircraft, and adept radar operators could lead the chaff trail with either SAMs or AAA.^{5/}

For active defense against SAMs, an IRON HAND flight of specially equipped F-105Fs accompanied the strike force. The aircraft carried electronic gear to detect and identify ground radars used in conjunction with both SAMs and AAA; air-to-ground, radar-homing missiles to put the radar off the air and mark the site; and iron bombs to destroy the sites so located. The IRON HAND flight had to precede the strike force, so that its own equipment was not affected by the force's ECM, as well as to be in position to protect the force. Yet, if IRON HAND were too far in advance, the isolated flight with no ECM coverage was an easy target for MIGs. The best compromise was three - six miles in front of the strike force.^{6/}

En route to the target, IRON HAND's function was to warn the force of electronic threats, and especially SAM launches. During the attack phase, IRON HAND circled the target, attempting to keep a missile pointed toward the threat, ready to fire if a radar came on the air or a SAM were launched. The electronic equipment provided much information concerning intercepted radar signals, but not range, which could be estimated only from the strength of the signal. Knowing when to fire was difficult. When carrying the AGM-45 SHRIKE, the aircrews drew 10-12 mile circles around suspected SAM sites and fired only when within those circles. The missile launch required a climbing delivery, and even the

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use of afterburner left IRON HAND in a critical position at the time of firing. If a SAM site were identified either by a SHRIKE hit or by seeing the smoke of a missile launch, IRON HAND could attack the site with hard ordnance; but this sometimes conflicted with the primary mission of escorting the strike force.^{7/}

The longer range AGM-78 STANDARD ARM was a second generation air-to-ground radar-homing missile which could be fired beyond range of the SAM. Incorporating a memory feature, it allowed the missile to continue guiding to the last known source of radiation even if the ground radar shut down. When two IRON HAND flights, one equipped with each type of missile, accompanied the strike force, the SHRIKE flight stayed with the force across the target, giving warning to the strike force and the STANDARD ARM flight. Although this was the concept of employment for AGM-78, it was not operationally used due to the bombing pause in late March 1968. USAF employed only eight AGM-78s on a special mission in early March 1968. The STANDARD ARM held 25-30 miles outside the target area, ready to acquire radar signals and fire missiles when alerted by the SHRIKE flight, hopefully destroying the SAM site before a missile could be launched. The SHRIKE flight, being closer to the SAM site, followed up with conventional bombs.^{8/}

For passive defense against MIGs, the strike force depended upon radio warnings from various USAF and USN agencies over Laos, in South Vietnam, and off the North Vietnamese coast.^{9/} For active defense, F-4s flew combat air patrol (CAP). If two CAP flights were attached to the

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force, one, the "fast" CAP, was armed with missiles and flew high, ready to move out and engage any threatening MIGs. The preferred intercept distance was 20 miles from the force. If hit farther out than that, the MIGs would have time to reform: if closer, they might fly head-on through the F-4s and attack the strike force. The second CAP flight, armed with guns, doubled as a strike flight by carrying hard ordnance which restricted its speed. If the fast CAP were committed, the "slow" CAP prepared to jettison ordnance and take on any MIGs that came close to the force. Commanders worried about their pilots' declining experience in aerial combat maneuvering and attempted to have them brush up these skills when returning from missions. Only the relatively few sorties that had not been exposed to ground fire were permitted to do so, however, because unknown battle damage, aggravated by high-G maneuvers, could lead to structural failure.^{10/}

In addition to IRON HAND and CAP flights, a strike force sometimes contained a flight of reconnaissance aircraft for instantaneous bomb damage assessment. A number of COMBAT MARTIN EF-105Fs had back cockpits filled with VHF equipment capable of jamming communications, but they were never used. The EF-105Fs were not to operate as a separate flight but were to be integrated into strike flights carrying ordnance and releasing it on signal from a strike aircraft.^{11/}

Controlling this small armada, which covered about 25 square miles and resembled a World War II bomber formation (except for the high speed), took no little skill on the part of the force commander (Fig. 11). For

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safety, the speed had to stay as high as was operationally practicable. Midrange afterburner was used for the last few minutes approaching the target, saving the high burner range for individual aircraft that needed it to catch up after a turn. The force had to maneuver, both in heading and altitude, while in AAA areas, but such a large force could not engage in violent jinking. Neither could it make wide, sweeping turns safely. The jammers put out most energy near the plane of the aircraft, so that a bank largely destroyed the ECM protection. The safest method was to turn in increments, a sharp turn for a few seconds, followed by wings level, and then another short turn. The quickest way to reverse course, as when aborting the force, was a maximum-G, in-place turn, which resulted in the formation flying in reverse order. Some ECM protection during the turn was provided by the leading flights dropping chaff at mid-turn.^{12/}

When carrying conventional ordnance, flights attacked individually and each aircraft made a single pass. It was essential that the first aircraft roll-in as quickly as possible; otherwise succeeding aircraft and flights tended to bunch up on the perch, exposing themselves for unnecessary periods. The desired interval between aircraft in a flight was 1-2 seconds, which permitted varying attack headings, while expediting recovery into pod formation after the attack. ECM protection was lost only during the attack itself; coming off the target, pilots were told that, if they could not find their own leader, they should join up with any friendly flight until beyond the high-threat area. On the other hand, flights carrying laser-guided PAVE WAYS could maintain

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a semblance of the pod formation during the dive, with the exception of the illuminator aircraft, which was badly exposed for several seconds (Fig. 12). With the electro-optically-guided PAVE WAY, the pod formation could be maintained throughout the attack, if the four aircraft attacked the same target or separate targets close together. ^{13/}

Making an airborne radar run with a strike force complicated the attack sequence further. For level radar bombing, the flight, and flights within the strike force, needed to be positioned precisely to attain the desired impact pattern; the formation usually differed from the optimum pod formation. The shift into bombing formation therefore had to be delayed as long as possible, to retain ECM protection. Because all aircraft released on the force commander's signal, it was a temptation for other aircrews to use their radars to maintain precise formation. This was not allowed for three reasons: (1) radar should be searching for MIGs, not locked onto another member of the formation; (2) maximum visual searching for MIGs and SAMs was essential; and (3) radar easily broke lock at short slant ranges. Reestablishing lock-on required backing out to 2,500-3,000 feet, which was "out of the question in a high-threat area." The solution was to practice station-keeping with radar when returning from missions or shuttling to a tanker, and learning to estimate the distances visually. ^{14/}

The CAP flight would accomplish nothing by exposing itself to the point defenses at the target unless MIGs were present. But coming off the target, MIGs were usually the greatest threat, and the CAP took

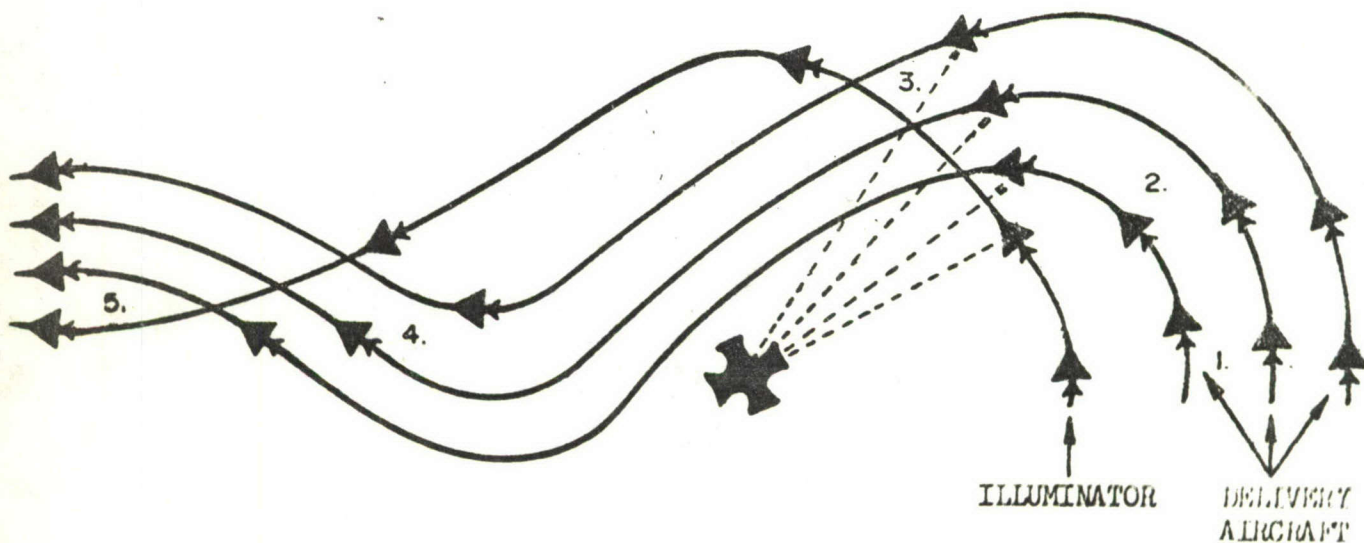
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DELIVERING LASER-GUIDED PAVEWAYS IN HIGH-THREAT AREA

1. When lead calls "tgt in sight" delivery aircraft make AB climb to approximately 16,000' & start roll-in ASAP - Illuminator acquires tgt & descends to approximately 12,000' calling "cleared to release" ASAP.
2. Delivery aircraft release ASAP in pod & break right-illuminator illuminates tgt until impact & then breaks to join flight in pod.
3. Flight rejoins as pod.
4. Egress area in pod approximately 15,000'.



1. Flight enters area in pod at approximately 15,000'.

SOURCE: 8TFWM 3-1, Aug 69, p. 5-48.

FIGURE 12

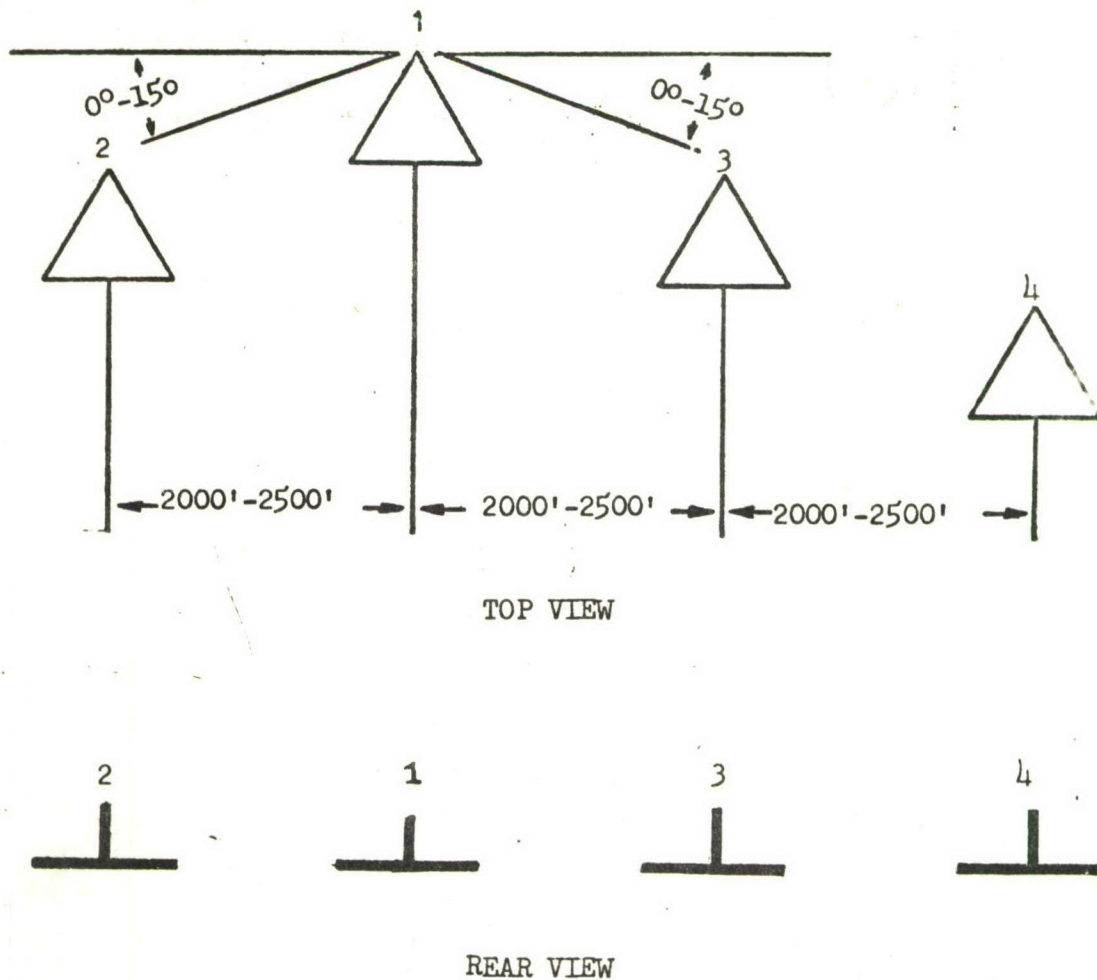
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STRIKE FLIGHT ANTI-MIG FORMATION



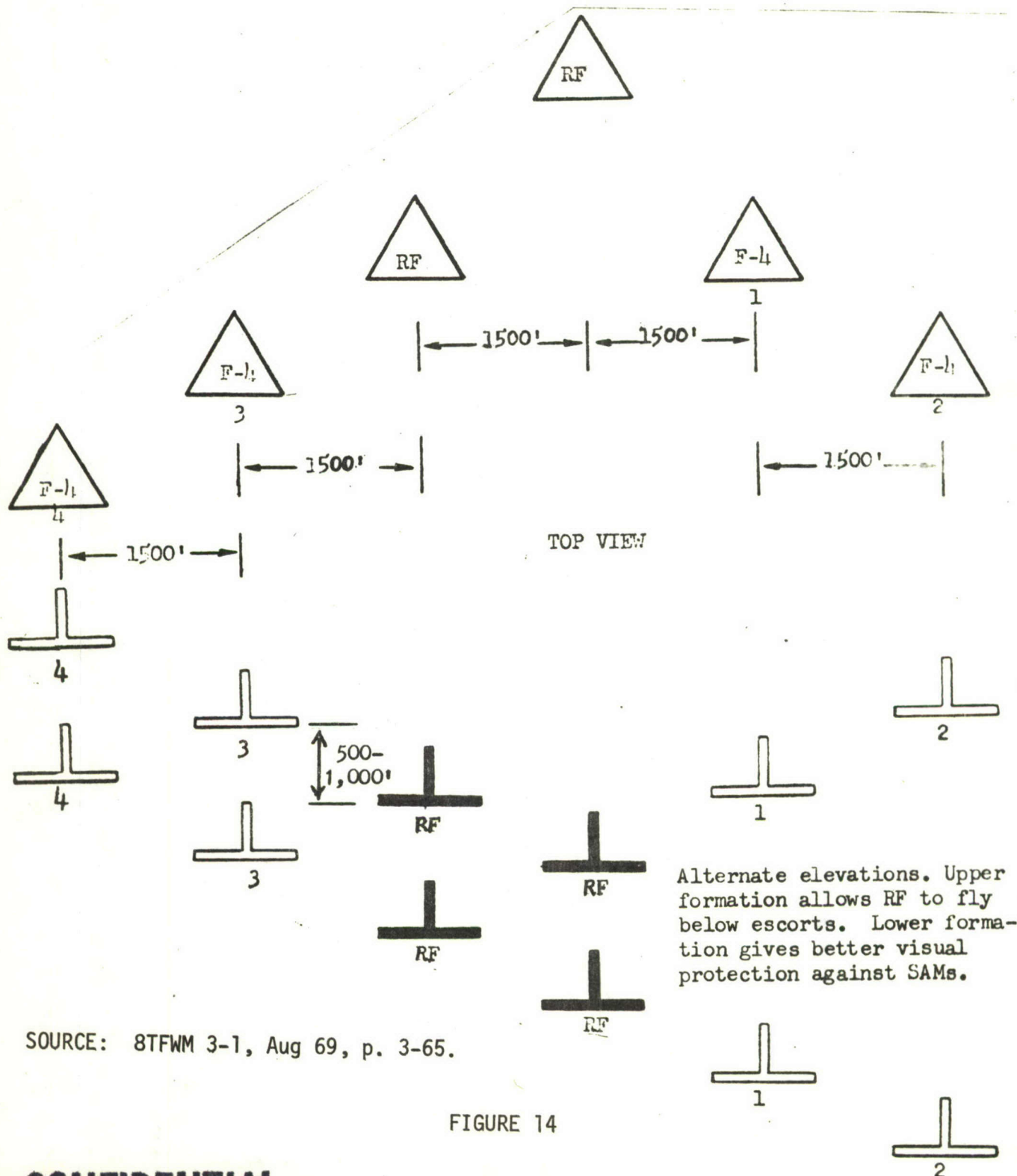
SOURCE: 8TFWM 3-1, Aug 69, p. 5-18.

FIGURE 13

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F-4s ESCORTING RF-4/RF-101 FLIGHT



SOURCE: 8TFWM 3-1, Aug 69, p. 3-65.

FIGURE 14

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position to cover the strike aircraft as they rejoined. When out of the SAM area, each flight assumed a near-line-abreast formation for maximum visual detection of MIGs (Fig. 13). Individual flights could generally defend themselves on the way home. IRON HAND often still had external ordnance, however, and required the protection of the CAP. Otherwise, the CAP flights were often released to troll for MIGs. A damaged aircraft automatically set the pace for the flight, and it was sometimes convenient to give that aircraft the lead position, but without the responsibility of leading the flight. Aircrews were cautioned against flying too closely when checking for battle damage: pieces coming off damaged aircraft had caused additional aircraft losses.^{15/}

After the bombing halt, reconnaissance flights continued over North Vietnam. Manned aircraft were used where they could reasonably be expected to survive, and drones appeared in the more hazardous areas. Each type required protection, but of very different kinds.

Two reconnaissance aircraft were usually escorted by a MIG CAP of four F-4s. The combined flight used an ECM pod formation (Fig. 14), unless a very low ceiling inhibited maneuvering of so large a flight. When MIGs threatened, two of the F-4s were committed against them, unless the resulting odds dictated that the entire escort flight be committed. Oblique cameras could be used to avoid point defenses more often than in Laos, because larger areas of land in North Vietnam had been cleared.^{16/}

Drones flew the more hazardous reconnaissance missions with remote ECM protection from EB-66s. The EB-66 jammers, like those in the fighter

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pods, radiated maximum power near the plane of the aircraft and gave only marginal coverage in turns. For these reasons, two EB-66s supported each drone flight, synchronizing their orbits so that at least one would always be straight and level (Fig. 15). The orbits were chosen to provide maximum jamming from the time the C-130 released the drone and through the critical stages of its flight. In March 1969, a new, steerable antenna was introduced on the EB-66; it proved particularly effective in protecting drones against SAMs. ^{17/}

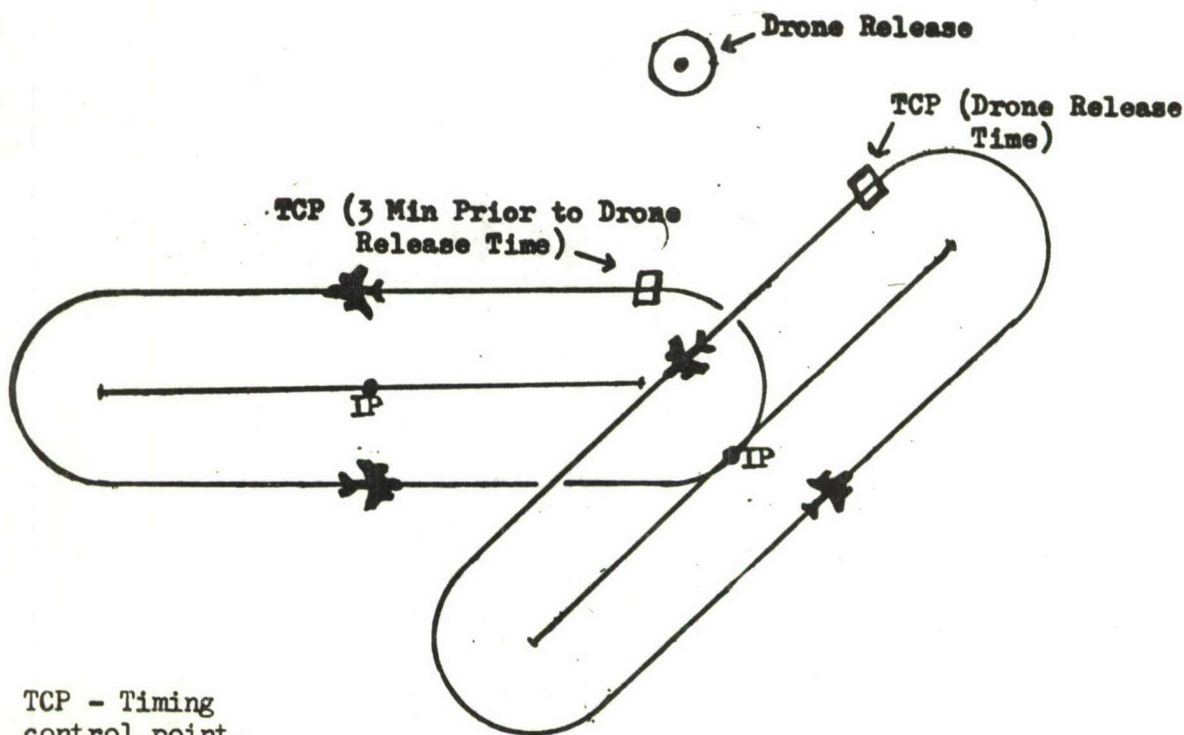
In these ways, though at a lower level of effort than before the bombing halt, the USAF continued to challenge the sophisticated defenses of North Vietnam, and commanders attempted to retain the capability to resume the full air war there, should it be ordered.

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EB-66 ORBITS FOR DRONE FLIGHT



SOURCE: 355TFW EB-66 Tactics Manual for SEA, vol. 1, Jul 69, p. 5-14.

FIGURE 15

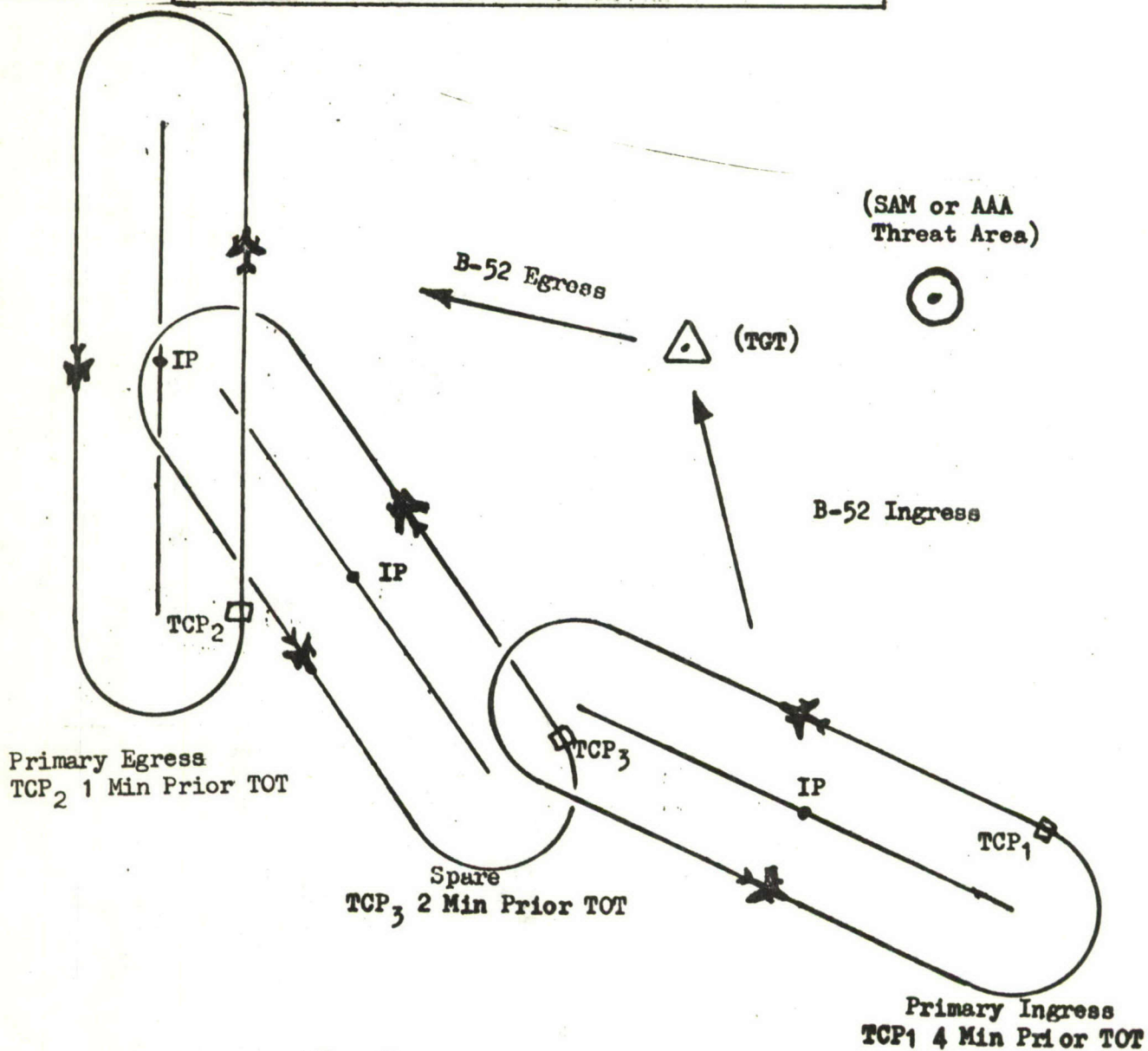
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EB-66 ORBITS IN SUPPORT OF B-52 MISSION



TCP - timing control point

TOT - time over target

Source: 355TFW EB-66 Tactics Manual for
SEA, vol. 1, Jul 69, p. 5-15.

FIGURE 16

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CHAPTER V

DEFENSE OF B-52s OPERATING NEAR NORTH VIETNAM

The B-52 loaded with iron bombs was the most devastating single weapon system of the war in SEA. In the Republic of Vietnam, the aircraft operated with impunity; no hostile weapons could approach its operating altitude. When B-52s took part in the interdiction campaigns in southern Laos, however, they came within range of 85 and 100-mm AAA which the North Vietnamese had placed in mountain passes on both sides of their border. During 1969, B-52s encountered 35 AAA reactions over Laos, culminating with 100-mm fire the last week of the year. The expansion of the North Vietnamese MIG force and the extension of SAM sites to the border areas (Chapter I) also posed distinct threats, particularly because the SA-2 SAM had been designed to destroy high altitude, non-maneuvering targets. The effectiveness of the B-52 warranted enemy efforts at deterrence, but political and psychological advantages that would follow the destruction of one of the big bombers would be far greater than any strictly military gain.^{1/} Therefore, when the B-52s struck near the North Vietnamese Border, the USAF gave the bombers the same kind of protection afforded the strike force described in Chapter IV.

The ECM equipment of bombers was supplemented by EB-66s. When the target was within 20NM of a SAM or AAA threat area, three EB-66s took the positions shown in Figure 16, flying between 26,000 and 31,000 feet. The aircraft on the middle orbit was an airborne spare, but if neither of the two primary aircraft had to be replaced, the spare flew the

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pattern as shown and acted as an active jammer. When the target was beyond 20NM of a SAM or AAA threat, only two EB-66s were fragged to fly a common orbit at different altitudes. This orbit was placed between the target and the threat, if there were sufficient space; otherwise the two aircraft flew the middle orbit as shown in Figure 16. The EB-66 crews jammed early warning and ground control intercept radar frequencies and monitored SAM frequencies, being prepared to concentrate on the latter if a SAM threat developed.^{2/}

Active defense against SAMs was provided by an IRON HAND flight of four F-105Fs, operating as two elements. One element orbited on either side of the target, between the B-52 track and the threat if there were sufficient space. IRON HAND operated between 10,000 and 15,000 feet and the two aircraft in each element took altitude separation, so that the crews could give maximum attention to potential SAM activity. Further, Number 2 flew 10-15NM in trail, which permitted both aircraft to attack an active site in rapid succession, but without mutual interference. Both F-105Fs and EB-66s flew well below the operating levels of the B-52s, and the lower aircraft had to be careful to avoid passing beneath the bombers near the target. The supporting crews were not guaranteed weather conditions that would permit them to sight SAMs early enough for successful evasion. Rather, the crews were told that, no matter what the weather, "If the B-52s go--you go!"^{3/}

The F-4s provided a CAP for protection against MIGs. In daytime, clear weather, they flew a racetrack pattern; at night, or in weather,

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a figure 8 gave better radar search capability. The F-4s maneuvered between the bombers and the threat, advancing their pattern with the bombers. To respond immediately to a MIG which possibly would not be detected until on a firing pass, the fighters kept their speed at .8-.9 mach all the time. The F-4 pilots were instructed to force the MIGs to lower altitudes and then continue the engagement only if they had an advantage.^{4/}

One difficulty should now be apparent: a number of supporting aircraft were squeezed into the limited space between the B-52 target and the North Vietnamese Border. At one point, the Commander of the 355th Tactical Fighter Wing said that his IRON HAND crews were "totally ineffective" when they could not operate between the bombers and the threat. He then asked that the Rules of Engagement be changed to allow IRON HAND flights inside North Vietnam when it was necessary to support B-52 operations near the border.^{5/} If SAM sites were positioned on the border, however, IRON HAND would be equally ineffective if orbiting behind the site--on the side opposite the B-52 track. In fact, if the SAM site were located very near the target, the B-52s were exposed. After the unsuccessful SAM attack on the B-52s the night of 19 December 1969, the big bombers were not allowed into the high-threat areas. Thereafter a "case by case analysis" was made of "all targets in the potential threat area," before approving a strike.^{6/}

The tendency toward stereotyped tactics, discussed generally in Chapter II, also appeared in B-52 support. The EB-66s and IRON HAND

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had to enter the target area ahead of the B-52s. To prevent giving automatic warning of an impending strike with their appearance, EB-66 sorties were sometimes fraggged into the border areas as a diversion. In March 1970, the F-4 aircrews who escorted the B-52s noted their patterns and altitudes had become too standardized, allowing MIG pilots to predict the F-4 positions and thereby gain a possibly decisive advantage for a hit-and-run attack. Seventh Air Force Operations Plan 775 restored a degree of " 'fluid' tactical thinking" into the fighter escort procedures.^{7/}

The heightened MIG threat resulted in a change to the procedure for diverting the B-52s. Threat Decision Points were established along the bomber tracks, so that if diversion to an alternate target were required, the bombers would be headed away from the MIG threat.^{8/} Rules governing diversion of these bombers were detailed--frequently changed.

If North Vietnam achieved one objective by forcing the withdrawal of B-52s from the areas immediately adjacent to its border, it had failed in its larger object of shooting one down. Judged on that basis, the many measures taken to protect the bombers had been successful.

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FOOTNOTES

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(S/NF) WAIS, Hq 7AF, 70-01, pp 6-8;
(S/NF) WAIS, Hq 7AF, 70-04, pg 7;
(S/NF) WAIS, Hq 7AF, 70-05, pp 9-11;
(S/NF) WAIS, Hq 7AF, 70-07, pg 19. (MICROFILM);
(S) Ltr, D000, PACAF to DOVD, PACAF; subj: "USAF Tactics Against Air Ground Defenses in SEA (U)", 29 Jul 70.
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(S/NF) WAIS, Hq 7AF, 70-12, pp 2-4;
(S/NF) WAIS, Hq 7AF, 70-14, pp 2-4. (MICROFILM)
11. (S/NF) WAIS, Hq 7AF, 70-03, pp 7-8;
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(S) End of Tour Rprt, Col Floyd White, 5 Apr 68 - 7 Apr 69,
pg 15.
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AAA	Antiaircraft Artillery
AGL	Above Ground Level
ARRS	Aerospace Rescue and Recovery Squadron
CAP	Combat Air Patrol
CBU	Cluster Bomb Unit
CSG	Combat Support Group
ECM	Electronic Countermeasure
EOTR	End of Tour Report
FAC	Forward Air Controller
GCI	Ground-Controlled Intercept
GIB	Guy in Back
IP	Initial Point; Impact Point
KCAS	Knots Calibrated Airspeed
LOC	Line of Communications
mm	millimeter
NM	Nautical Mile
NVA	North Vietnamese
NVN	North Vietnam
OPlan	Operations Plan
Recon	Reconnaissance
RTAFB	Royal Thai Air Force Base
RVN	Republic of Vietnam
SAM	Surface-to-Air Missile
SEA	Southeast Asia
SVN	South Vietnam

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TCP	Traffic Control Point
TOT	Time over Target
TFW	Tactical Fighter Wing
TRW	Tactical Reconnaissance Wing
TV	Television
USN	United States Navy
VC	Viet Cong
VHF	Very High Frequency
VR	Visual Reconnaissance
WAIS	Weekly Air Intelligence Summary

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